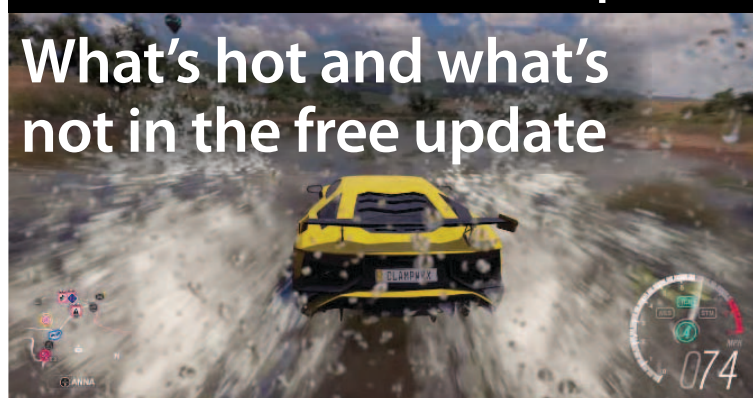# PC ADVISOR

FROM IDG

BEST PCs FOR GAMES

- ✓ Play in 4K
- ✓ VR ready
- ✓ Ryzen and Kaby Lake CPUs

PLUS Gaming laptops from Asus and Dell

Windows 10 Creators Update

What's hot and what's not in the free update

Samsung Galaxy S8

The best Android phone ever

Nvidia GTX 1080 Ti
The 3D power you need for 4K and VR gaming

REVIEW

JULY 2017

IDG ISSUE 264

What do you think of this issue of PC Advisor? We welcome feedback – email Jim Martin at **jim_martin@pcadvisor.co.uk** and include the issue number in the subject heading

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IDG

JIM MARTIN

Intel vs AMD

Our gaming PC group test pits Ryzen against Kaby Lake

Welcome to the July issue of *PC Advisor*. It's been another busy month with the release of the Creators Update for Windows 10, more Ryzen processors from AMD and plenty more besides.

The Creators Update is free, but it's still a little disappointing that it lacks much of the 3D capabilities Microsoft promised when it was announced last autumn. You can find out all about it in our review on page 20. It's still worth downloading of course, as there are lots of tweaks and new features.

This is also the first month we've been able to compare PCs with Ryzen CPUs against those with Intel's Kaby Lake chips (page 60). Although we asked system builders to put together PCs aimed at gamers, these are powerful machines that will handle anything you need to do and the Ryzen processors excel whenever their vast number of cores can be put to use.

Over the previous few weeks there has been much talk about Ryzen, some true and some not. We've sought to dispel the myths on page 77, so you're in a better position when it comes to choosing between Intel and AMD.

PCs are great for power and upgradability, but if you need performance in a portable package then check out Asus ROG Strix GL702VM on page 31 and Dell's Inspiron 15 7000 Gaming on page 36. They're quite different beasts and will suit different people.

If your current PC is lacking in the frames-per-second department, then Nvidia has a fantastic upgrade in the form of the GTX 1080 Ti (page 57). It isn't cheap, but if you have a 4K monitor or a VR headset the 1080 Ti has the necessary firepower to give you smooth experience.

There's also a battle to be the best flagship phone and while LG's G6 is a great contender (page 48) it can't quite top the sheer brilliance of the Galaxy S8 (page 44). Even if you're not thinking of upgrading your Android phone, you can do more with your current one. Google's new Gboard is a particularly great keyboard – you'll see why on page 113.

We're all taking more photos than ever before, especially on phones, and we've put together 25 tips on how to take your photography to the next level on page 80. While some are directed at DSLR owners, most apply to phones as well, so as the weather warms up, get snapping.

Finally, we've got our usual selection of great Windows tips from need-to-know shortcuts (page 73) to ditching the limited Task Manager and getting to grips with the altogether more powerful Process Explorer (page 94).

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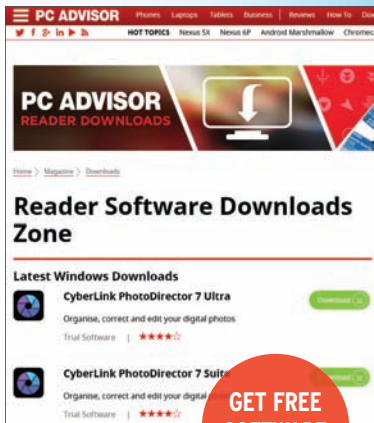
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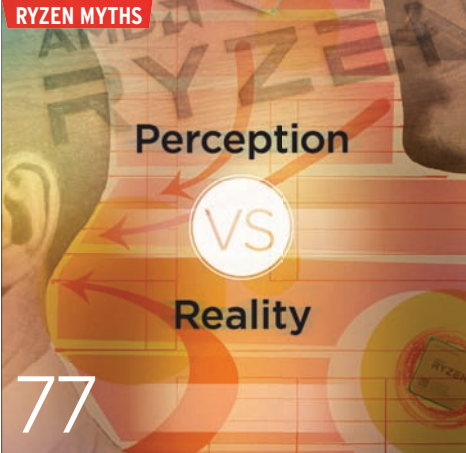
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TEST CENTRE

TOP 5 CHARTS: BUYER'S GUIDE

Future Intel CPUs could be cobbled together using different parts

Intel could tap a new high-speed interconnect to join different chips together to make future CPUs, writes Gordon Mah Ung

Today's processors, made using a single continuous slab of silicon, may soon give way to multiple chips interconnected at high speeds, Intel recently reported.

The chipmaker said that its new Embedded Multi-die Interconnect Bridge, or EMIB, technology would let a 22nm chip connect to a 10nm processor and a 14nm one, all on the same processor.

"For example, we can mix high-performance blocks of silicon and IP together with low-power elements made from different nodes for extreme

optimisation," said Intel's Murthy Renduchintala, who heads the Client, IoT and Systems Architecture Group.

That's a radical departure from how the company has constructed most CPUs and SoCs, where all components of a CPU

Today's CPUs are monolithic designs with all of the functionality built on the same process technology
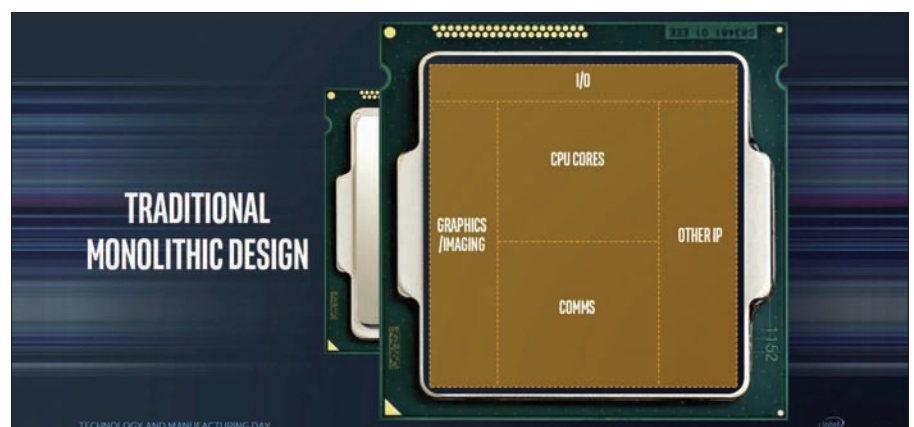
Future CPUs from Intel could fuse together multiple process technologies

or SoC are built on the same process. Renduchintala didn't commit EMIB to any particular upcoming SoC or CPU, but said it was clear the tech would play a large role in near- and long-term products from Intel. He added that EMIB can hit "multi hundreds of gigabytes" speeds while reducing latency by four times over traditional multichip techniques. "It's truly a transformational technology for Intel," he said.

With EMIB, Intel could build the CPU and graphics cores on a bleeding-edge 10nm process and keep lower-performance components on 14nm. Still other parts that might actually benefit from being fabbed on, say, the 22nm process, such as power circuits, could stick to the larger process. At one point Intel dabbled with integrating the voltage regulation into the CPU with its fourth-generation Haswell and fifth-generation Broadwell chips. With sixth-generation Skylake and seventh-generation Kaby Lake though, the integrated voltage regulation was yanked, which some believed was due to problems scaling the fully integrated voltage regulator down to 14nm. An EMIB version could potentially keep the FIVR at 22nm.

This isn't the first time that Intel has considered fusing two chips together in one CPU. The original Pentium Pro design was a multichip package as was the Core 2 Quad series of CPUs.

EMIB is far more advanced though, and is constructed within the silicon itself. A traditional multichip package design runs wires through the substrate that the chips are mounted to. That limits the amount of wires and speeds they can run at.

Another method is to use a silicon interposer to connect the dies. While this yields high wire density and high performance, it's expensive to manufacturer.

EMIB essentially makes it far easier to combine chips without giving up much of the

performance. Although Intel made a point of highlighting EMIB at its technology and manufacturing day for press and financial analysts, this isn't EMIB's first use. Intel actually introduced it with the Altera Stratix 10, which used EMID to construct the SoC.

Intel is already fabbing the Altera Stratix 10 by joining together multiple chips using its new EMIB interconnect

Intel says its Embedded Multi-die Interconnect Bridge is more cost effective than methods that use an interposer to connect chips and offers far better performance than multichip package designs

HP rises again to be the world's top PC maker as Lenovo slips

HP excelled in North America, which was decisive in helping it beat Lenovo. Agam Shah reports

HP's Omen X marks the company's return to enthusiast gaming

It was another tough quarter for PC shipments, but there was good news for HP, which edged Lenovo to regain the title of world top's PC maker, according to IDC.

Worldwide PC shipments totalled 60.3 million units in the first quarter of 2017, growing by just 0.6 percent compared to the same quarter the previous year.

IDC previously forecast a decline of 1.8 percent in PC shipments, so the positive growth was a sign the PC market is recovering. Quarterly PC shipments reported positive growth for the first time since the first quarter of 2012.

Lenovo previously beat HP for the title of the world's top maker in 2013 and has mostly held the position since then. HP regained the top spot this quarter boosted by strong laptop shipments worldwide. Now the question remains can HP hold the number one spot. A separate survey released by Gartner put Lenovo as the world's top PC maker. The numbers of IDC and Gartner don't match as the two firms measure PC shipments in different ways. For example, Gartner does not account for Chromebook shipments in its survey.

According to Gartner, worldwide PC shipments totalled 62.2 million units for the first quarter, down by 2.4 percent.

Nevertheless, the analyst firms agreed that PC shipments were held back by rising prices, which happened due to a shortage of NAND and DRAM. Prices of these components are expected to rise even more in the coming quarters, which could affect PC prices.

But the rising prices shouldn't stop PC shipments from picking up later this year. Businesses are expected to upgrade to the latest PCs, and they tend to spend more on laptops and desktops.

Lenovo took a beating in North America, which is the main reason it lost the top position in IDC's survey. HP did well in the region. PC shipments rebounded in Europe, while Asia-Pacific was soft.

HP has cut many low-priced PCs while focusing on high-end PCs and premium designs. Lenovo has come up with innovative PCs like Yoga, but its home market of China was weak.

According to IDC, HP's worldwide shipments totalled 13.1 million units, growing by 13.1 percent year-over-year, for a 21.8 percent market share. Lenovo's shipments totalled 12.3 million, growing by just 1.7 percent.

In third place was Dell; its shipments went up by 6.2 percent to 9.6 million. Fourth-placed Apple's shipments grew by 4.1 percent to 4.2 million. In close fifth was Acer, with shipments totalling 4.1 million.

FOR EVERYTHING
ANDROID

ANDROID ADVISOR

Verdict

The Galaxy Gear is a mixed bag. We love the stylish design and nice screen. It's packed with handy features, but performance and potentially poor battery life are concerns. You can use it with only a handful of Galaxy smartphones, and it's pricey.

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Wed, 4 Sep
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version for free will tempt more users to upgrade to the Premium service.

Spotify said users will be able to listen to their playlists and also hit 'shuffle play' to listen to a particular artist's entire back catalogue. The firm has started making available Led Zeppelin's back catalogue, releasing two albums per week.

The firm is also dropping the 10-hours-per-month limit that it had previously imposed in users of its free service.

While Spotify is available on iOS and Android smartphones and tablets, there are no apps for Windows Phone 8 and BlackBerry.

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Every issue is packed with the latest reviews, features, tutorials & more.

AMD's Ryzen Balanced power plan for Windows promises to boost CPU performance

AMD says the new plan will make Ryzen up to 21 percent faster, finds Gordon Mah Ung

AMD's new Ryzen Balanced power plan is offering an answer for early performance woes with its new CPU. The power profile tweaks how Windows 10 handles power states of the individual CPU cores and can bump performance from 3 percent all the way to 21 percent in many popular games, AMD said in a blog post.

To obtain and install the updated power plan, you can visit AMD's blog (tinyurl.com/mrpvq93 or download the zip file directly from AMD at tinyurl.com/mrpvq93.

AMD said the power plan, which will soon be rolled into a chipset driver package, tweaks Windows 10's treatment of virtual cores and physical cores. When Ryzen first arrived, many theorized that the Windows 10 scheduler – how an operating system doles out work to individual cores – was to blame for the gaming performance gap because Windows 7 was often faster. In the end, AMD absolved Windows 10 scheduler of any blame, but that doesn't mean Microsoft's top OS is also free and clear.

AMD's new Ryzen CPUs have proven to be highly competitive with Intel's offerings in applications, but gaming performance often trails Core i7. With the updated power plan, AMD hopes to close the gap.

Windows 7 versus Windows 10
Windows 7 keeps all physical cores awake and parks the virtual cores in CPUs. Windows 10, however, keeps one physical core and one virtual core awake and puts the rest asleep until they're needed. The updated power plan from AMD helps reduce performance hits by keeping the physical cores awake. Intel, AMD said, takes a similar path with its own power plans.

AMD, in fact, had already been recommending that consumers run the High Performance profile instead, which keeps all of the cores awake.

How much faster?
In testing, AMD said it found the largest performance increase came in Crysis 3, which saw a 21.6 percent bump compared to running the default Balanced power plan in Windows 10. Other games also saw decent improvements: Gears of War 4 saw a 16.5 percent boost. Battlefield 4 enjoyed a bump of 8.8 percent to 10 percent. Shadows of Mordor saw a 6 percent lift, and Grand Theft Auto V accelerated by 4.4 percent.

Here's the quick installation guide for installing the new profile: decompress the file and launch it under Windows 10. Windows 10 will ask for your permission to install the power profile, which should become the new default and look like the screen below. ⊠

AMD said Windows 10 power plan tweaks helps Ryzen's performance
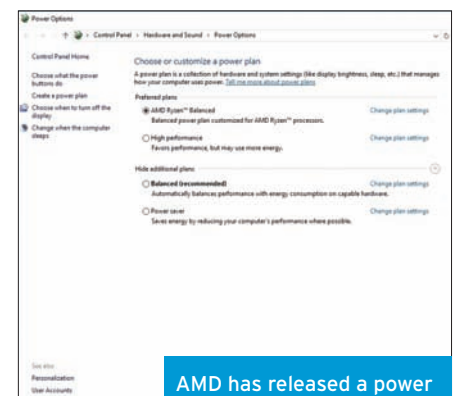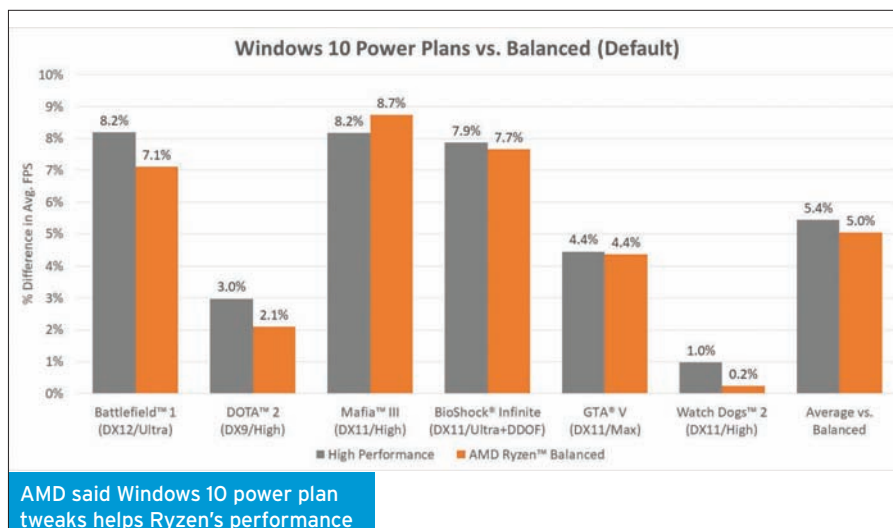
AMD has released a power plan for Windows 10 that it claims can bump gaming performance from 2 percent to 21 percent

Google says its AI chips smoke CPUs, GPUs in performance tests

The TPUs are faster at neural net inference and excel at performance per watt, reveals Blair Hanley Frank

Four years ago, Google was faced with a conundrum: if all its users hit its voice-recognition services for three minutes a day, it would need to double the number of data centres just to handle all of the requests to the machine learning system powering those services.

Rather than buy a bunch of new real estate and servers just for that purpose, the company embarked on a journey to create dedicated hardware for running machine-learning applications like voice recognition.

The result was the Tensor Processing Unit (TPU), a chip that is designed to accelerate the inference stage of deep neural networks. Google published a paper recently laying out the performance gains the company saw over comparable CPUs and GPUs, both in terms of raw power and the performance per watt of power consumed.

A TPU was on average 15- to 30 times faster at the machine learning inference tasks tested than a comparable server-class Intel Haswell CPU or Nvidia K80 GPU. Importantly, the performance per watt of the TPU was 25 to 80 times better than what Google found with the CPU and GPU.

Driving this sort of performance increase is important for Google, considering the company's emphasis on building machine learning applications. The gains validate the company's focus on building machine learning hardware at a time when it's harder to get massive performance boosts from traditional silicon.

This is more than just an academic exercise. Google has used TPUs in its data centres since 2015 and they've been put to use improving the performance of applications including translation and image recognition. The TPUs are particularly useful when it comes to energy efficiency, which is an important metric related to the cost of using hardware at massive scale.

One of the other key metrics for Google's purposes is latency, which is where the TPUs excel compared to other silicon options. Norm Jouppi, a distinguished hardware engineer at Google, said that machine learning systems need to respond quickly in order to provide a good user experience.

"The point is, the internet takes time, so if you're using an internet-based server, it takes time to get from your device to the cloud, it takes time to get back," Jouppi said. "Networking and various things in the cloud – in the data centre – they takes some time. So that doesn't leave a lot of [time] if you want near-instantaneous responses."
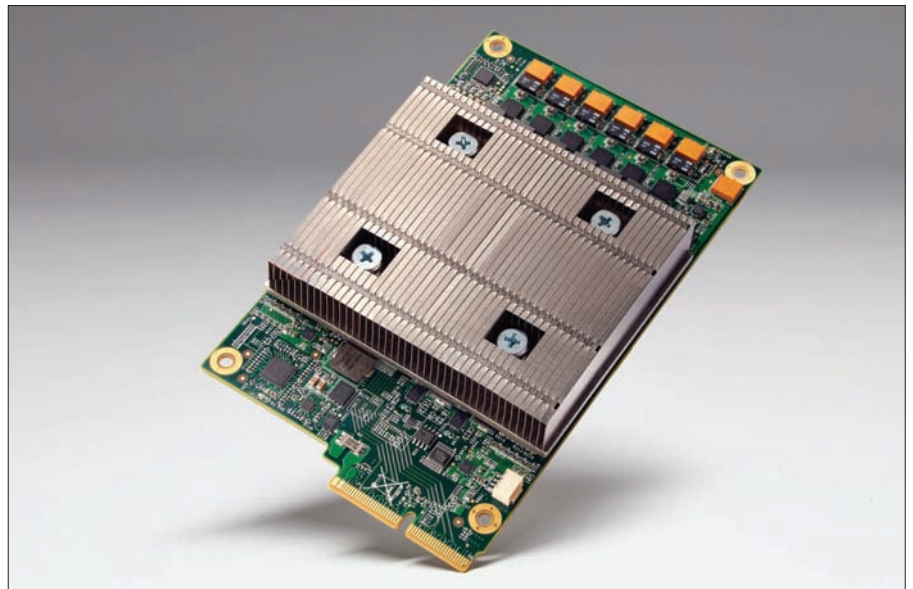
Google tested the chips on six different neural network inference applications, representing 95 percent of all such applications in Google's data centres. The applications tested include DeepMind AlphaGo, the system that defeated Lee Sedol at Go in a five-game match in 2016.

Performance
The company tested the TPUs against hardware that was released around roughly the same time to try and get an apples-to-apples performance comparison. It's possible that newer hardware would at least narrow the performance gap.

There's still room for TPUs to improve, too. Using the GDDR5 memory that's present in an Nvidia K80 GPU with the TPU should provide a performance improvement over the existing configuration that Google tested. According to the company's research, the performance of several applications was constrained by memory bandwidth.

Furthermore, the authors of Google's paper claim that there's room for additional software optimisation to increase performance. The writers called out one of the tested convolutional neural network applications (referred to in the paper as CNN1) as a candidate. However, because of existing performance gains from the use of TPUs, it's not clear if those optimisations will take place. While neural networks mimic the way neurons transmit information in humans, CNNs are modelled specifically on how the brain processes visual information.

"As CNN1 currently runs more than 70 times faster on the TPU than the CPU, the CNN1 developers are already very happy, so it's not clear whether or when such optimisations would be performed," the authors wrote.

TPUs are what's known in chip lingo as an application-specific integrated circuit (ASIC). They're custom silicon built for one task, with an instruction set hard-coded into the chip itself. Jouppi said that he wasn't overly concerned by that, and pointed out that the TPUs are flexible enough to handle changes in machine learning models. "It's not like it was designed for one model, and if someone comes up with a new model, we'd have to junk our chips or anything like that," he said.

Google isn't the only company focused on using dedicated hardware for machine learning. Jouppi added that he knows of several start-ups working in the space, and Microsoft has deployed a fleet of field-programmable gate arrays in its data centres to accelerate networking and machine learning applications. ⊠

Qualcomm says Apple using its power to pay less for a patent licence

Qualcomm is demanding damages and withheld payments from Apple writes John Ribeiro

PHOTOGRAPHY: ANN SINGER

Qualcomm is seeking damages from Apple, alleging that the iPhone maker interfered with long-term agreements between the chip company and licensees that manufacture the iPhone and iPad, and encouraged actions by regulators against the company by giving government agencies "false and misleading information".

Apple did not use certain high-performance features of the Qualcomm chipsets for the iPhone 7, claims the chipmaker. When iPhones with the Qualcomm processor still outperformed iPhones that used a chipset from key rival Intel, Apple is said to have publicly claimed that there was "no discernible difference" between iPhones using Intel chipsets and those using Qualcomm processors, when it knew the opposite to be true, according to a recent filing by Qualcomm.

Apple warned that if Qualcomm were to make or sponsor public comparisons of the Intel and Qualcomm-based iPhones, Apple would use the marketing resources at its disposal to "retaliate" against Qualcomm and its standing as an Apple chipset supplier would be jeopardised.

The filing in the US District Court for the Southern District of California is in response to a lawsuit Apple filed against the company in January, accusing the chip supplier of charging "exorbitant" licensing fees for its cellular technology.

Apple is seeking nearly $1 billion in compensation for paying excessive royalties to Qualcomm. The company said in its filing in January that Qualcomm's licensing model is based on the final selling price of a device, so that the royalty paid for its standard-essential patents by makers of high-value phones will be higher than that paid by makers of basic mobile phones.

The smallest saleable unit for a cellular SEP license should be no greater than the baseband processor chipset, Apple argued. It also wants Qualcomm to negotiate single-patent licenses rather than offer a license to its patents as a single portfolio.

Both companies have a lot at stake. Apple would like to find ways to lower the cost of its iPhones, particularly in newer, price-sensitive markets, while Qualcomm makes a significant portion of its revenue from licensing its intellectual property.

In its response, Qualcomm portrays Apple as using its considerable power to try to get lower royalty rates from the chip company. After filing the lawsuit in the court in California, Apple also sued Qualcomm in China, the UK and Japan as part of "its aggressive strategy of constructing commercial disputes and then claiming it has been victimised," according to the filing.

When asked for comment, a spokesman for Apple referred back to the company's statement in January in which it claimed that Qualcomm had insisted on charging royalties for technologies they have nothing to do with.

"The more Apple innovates with unique features such as TouchID, advanced displays, and cameras, to name just a few, the more money Qualcomm collects for no reason and the more expensive it becomes for Apple to fund these innovations," the iPhone maker said in that statement, when filing the suit against Qualcomm in the California court.

Apple said that Qualcomm has taken "increasingly radical steps", including most recently by withholding nearly $1 billion in payments from Apple as retaliation for its

"truthful responses" to law enforcement agencies investigating the chip company.

Qualcomm holds that "latecomer" Apple contributed virtually nothing to the development of core cellular technology and has depended heavily on Qualcomm technology to become the dominant player in the cellphone market. "Now, Apple wants to pay far less than fair value for a license to Qualcomm's patents," it added.

The chipmaker alleged that Apple interfered, and continues to interfere, with the chip maker's long-standing contracts with the manufacturers of Apple's cellular devices, leading them to withhold certain royalties owed to Qualcomm, according to the redacted filing. The contracts with manufacturers such as Compal, Wistron, Pegatron and Foxconn were signed even before Apple started using Qualcomm chipsets in its products. Rather than enter into a contract directly with Qualcomm, Apple chose to rely on the contracts Qualcomm had with the manufacturers.

The chipmaker also claims that Apple has withheld money owed to it under another contract relating to a high-speed feature of its chipset.

In negotiations between the two companies for a patent agreement, Apple is said to have offered to pay Qualcomm royalties per phone that would be "a small fraction of the royalty" paid by other smartphone vendors.

Qualcomm also accuses Apple of giving false information to regulators. The chip company was fined in December by South Korea's antitrust regulator for violating antitrust laws. By January, the US Federal Trade Commission accused it in a lawsuit of strong-arming phone makers into accepting unfair licensing terms while giving Apple a break in exchange for exclusivity.

The chip company now charges that Apple misled the Korea Fair Trade Commission on 17 August 2016 by testifying, for example, that "Apple has yet to add a [second chipset] supplier because of Qualcomm's exclusionary conduct". Apple had already at the time added Intel as a second baseband chip supplier and purchased Intel chips to include in the iPhone 7, which was only a few weeks away from its September release, according to the filing. ⊠

Lawsuit alleges Microsoft's Windows 10 upgrade destroyed data and damaged PCs

'Claims are without merit,' Microsoft counters. Gregg Keizer reports

Three people from Illinois are taking Microsoft to court, claiming that the free Windows 10 upgrade they had installed on their PCs caused "data loss and damage to their computers".

Lawyers for the trio asked a Chicago federal court recently to grant the case class-action status, which would allow other Americans to join the litigation.

"Many consumers have had their hard drives fail because of the Windows 10 installation," alleged the complaint. "Many consumers have had their existing software and data rendered inoperable by the Windows 10 installation."

All three of the plaintiffs asserted that after accepting the free Windows 10 upgrade – a one-year deal that ran from 2015 to 2016 – some data on their Windows PCs had been destroyed. One said that she had had to purchase a new personal computer after the one upgraded to Windows 10 was crippled.

Howard Goldberg of Chicago had a particularly tough time with the Windows 10 upgrade. "After three attempts to download Windows 10, each of which tied up his computer for extended periods of time, Goldberg's computer was damaged, and Windows 10 was not actually downloaded and functional," the complaint read. "Goldberg contacted Microsoft about the problems, and was told his computer was out of warranty, and that he would have to pay them for any assistance with the problems. Goldberg therefore had to have somebody repair the computer to make it functional."
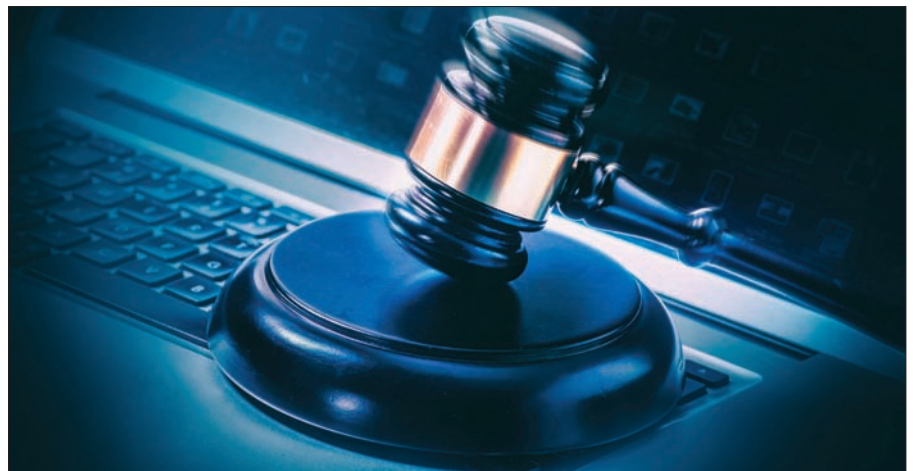
Many of the plaintiffs' complaints resembled the general malaise widely reported during the one-year upgrade plan. For example, the lawsuit cited the insistent on-screen upgrade nag notices Microsoft placed on consumers' Windows 7 and 8.1 desktops, the limited-time window when the PC could be rolled back to its previous operating system, and the shifty reversal of the close-window operation in a critical dialog box.

"We believe the plaintiffs' claims are without merit," a Microsoft spokesperson said in a statement. It also pointed out that "customers had the option not to upgrade to Windows 10" and added that users also could contact the company's free technical support.

Others have taken Microsoft to court over Windows 10. In July 2016, three Florida men alleged that the company "coerced" them into upgrading to Windows 10 and that the "unintentional" upgrades damaged their PCs. That case was dismissed earlier this year.

Also in 2016, a California woman took Microsoft to small claims court, where she was awarded $10,000 after she convinced a judge that an unauthorised upgrade to Windows 10 had crippled her work computer.

The lawsuit asked that Microsoft pay both actual and punitive damages. ⊠

Researchers build a microprocessor from flexible materials

It's a one-bit microprocessor with four instructions, but it could open the way to more flexible electronics, writes Peter Sayer

R esearchers have built a primitive microprocessor out of a two-dimensional material similar to graphene, the flexible conductive wonder material that some believe will revolutionise the design and manufacture of batteries, sensors and chips.

With only 115 transistors, their processor isn't going to top any benchmark rankings, but it's "a first step towards the development of microprocessors based on 2D semiconductors," the researchers at Vienna University of Technology said in a paper published in the journal *Nature*.

Two-dimensional materials have the benefit of flexibility, meaning that they can be incorporated more easily into wearable devices or connected sensors, and potentially making them less breakable: Picture a smartphone that bends rather than breaks if you drop it.

Today's semiconductors and screens are already pretty thin, but they still rely on the three-dimensional physical properties of the materials they're made from in order to function. Bend a silicon wafer and it will crack. But 2D materials like graphene or the transition-metal dichalcogenide (TMD) used by the Vienna researchers, are truly two-dimensional, made with crystals just one layer of atoms or molecules thick, allowing them to flex.

TMDs are compounds composed of a transition metal such as molybdenum or tungsten and a chalcogen (typically sulphur, selenium or tellurium, although oxygen is also a chalcogen). Like graphene, they form into layers, but unlike graphene which conducts electricity like a metal, they are semiconductors, which is great news for flexible chip designers.

Stefan Wachter, Dmitry Polyushkin and Thomas Mueller of the Institute of Photonics, working with Ole Bethge of the Institute of Solid State Electronics in Vienna, decided to use molybdenum disulfide to build their microprocessor.

They deposited two molecule-thick layers of it on a silicon substrate, etched with their circuit design and separated by a layer of aluminium oxide.

"The substrate fulfils no other function than acting as a carrier medium and could thus be replaced by glass or any other material, including flexible substrates," they wrote.
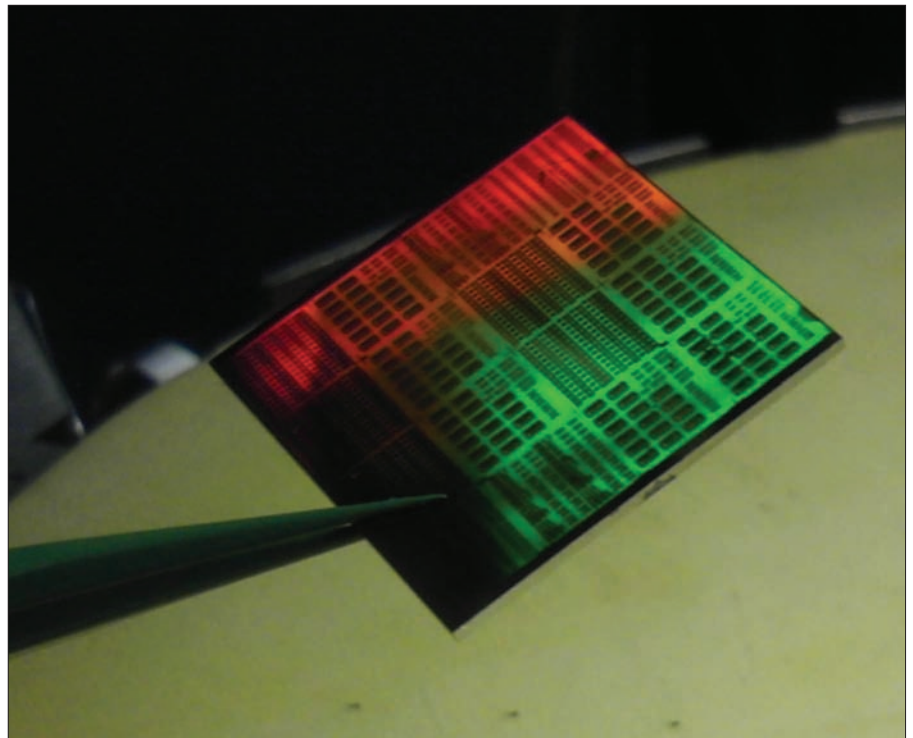
Recent Intel microprocessors act on data in 64-bit 'words', can understand hundreds or even thousands of different instructions, depending on how you count them, and contain hundreds of millions of transistors.

In contrast, the microprocessor built by the researchers is only capable of acting on data one bit at a time, using a set of just four instructions (NOP, LDA, AND and OR), and the circuit features used to build it are of the order of two micrometers across, 100 times larger than those found in the latest Intel and ARM processors. With more work, though, the microprocessor's complexity could be increased and its size reduced, the researchers said. They deliberately chose an overly large feature size for their manufacturing process to reduce the effects of holes, cracks and contamination in the molybdenum disulfide film and to make it easier to inspect the results with an optical microscope.

"We do not see any roadblocks that could prevent the scaling of our 1-bit design to multi-bit data," they said, and only the challenge of lowering contact resistance stands in the way of sub-micrometer manufacturing.

That's not to say it will be easy: although the manufacturing yield for subunits was high, with around 80 percent of the arithmetic-logic units fully functional, their non-fault tolerant design meant only a few percent of finished devices worked properly.

Commercial microprocessor manufacturers deal with yield problems by making their chip designs modular, and testing them at a variety of speeds. Processors that work at higher speed fetch higher prices, while faulty subcomponents can be permanently disabled and the resulting chips, otherwise fully functional, sold as lower-specification models.

It's taken 46 years for Intel to get from the 4004, a four-bit central processor with 46 instructions, to the latest incarnation of the x86 architecture, Kaby Lake: with all that the industry has learned about micromanufacturing since then, progress with flexible semiconductors may be a little faster. ⊠

It's time to dump Moore's Law to advance computing, researcher says

An end to Moore's Law will prompt chipmakers to think outside the box, reveals Agam Shah

Dumping Moore's Law is perhaps the best thing that could happen to computers, as it'll hasten the move away from an aging computer architecture holding back hardware innovation.

That's the view of prominent scientist R. Stanley Williams, a senior fellow in the Hewlett Packard Labs. Williams played a key role in the creation of the memristor by HP in 2008.

Moore's Law is an observation made by Intel co-founder Gordon Moore in 1965 that has helped make devices smaller and faster. It predicts that the density of transistors would double every 18- to 24 months, while the cost of making chips goes down.

Every year, computers and mobile devices that are significantly faster can be bought with the same amount of money thanks in part to guidance from Moore's Law. The observation has helped drive up device performance on a predictable basis while keeping costs down.

But the predictions tied to Moore's Law are reaching their limits as it becomes harder to make chips at smaller geometries. That's a challenge facing all top chipmakers including Intel, which is changing the way it interprets Moore's Law as it tries to cling on to it for dear life.

Williams is the latest to join a growing cadre of scientists who predict Moore's Law is dying. The end of Moore's Law "could be the best thing that has happened to computing in decades," Williams wrote in a research paper published in the latest issue of *IEEE Computing in Science and Engineering*.

The end of Moore's Law will bring creativity to chip and computer design and help engineers and researchers think outside the box, Williams said. The law has bottled up innovation in computer design, he hinted.

So what's next? Williams predicted there would be computers with a series of chips and accelerators patched together, much like the early forms of superfast computers. Computing could also be memory driven, with a much faster bus driving speedier computing and throughput.

The idea of a memory-driven computer plays to the strength of HPE, which has
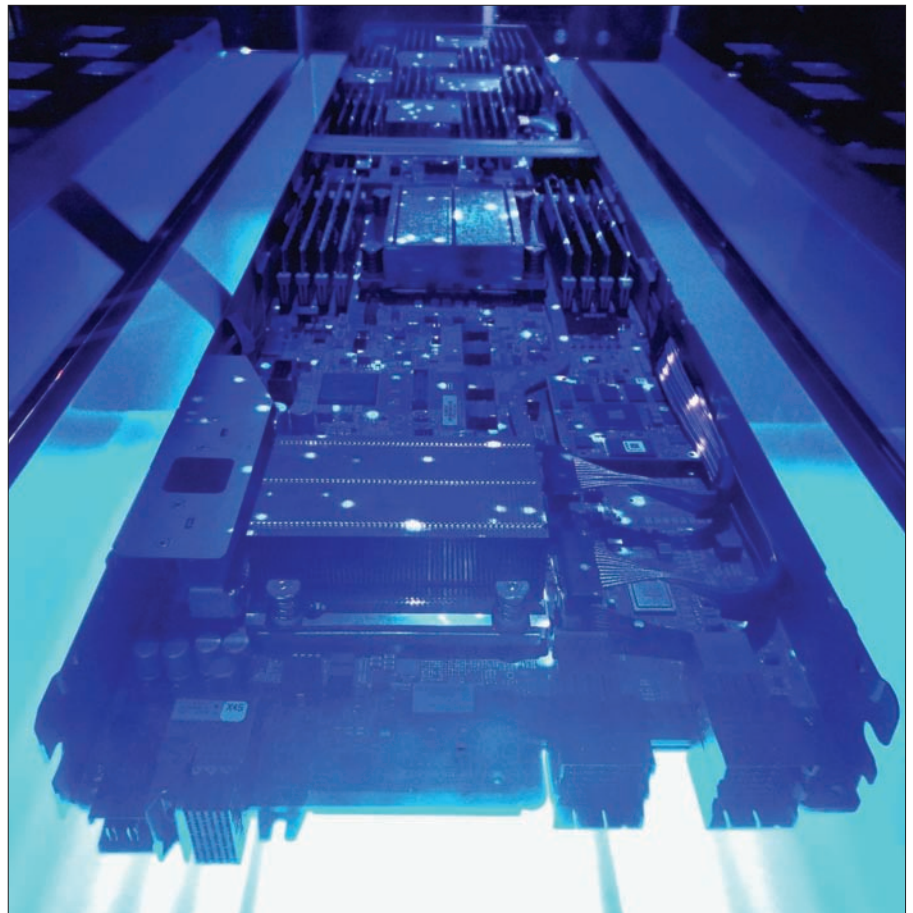
built The Machine along those lines. The initial version of The Machine has persistent memory that can be used as both DRAM and flash storage but could eventually be based on memristor, an intelligent form of memory and storage that can track data patterns.

Memory-driven computing could also break down the current architecture-based and processor-centric domination of the computer market. In the longer term, neuromorphic chips designed around the way the brain works could drive computing.

In the longer term, neuromorphic chips that are designed around the way the brain works could drive computing. HPE is developing a chip designed to mimic a human brain, and similar chips are being developed by IBM, Qualcomm, and universities in the US and Europe.

"Although our understanding of brains today is limited, we know enough now to

design and build circuits that can accelerate certain computational tasks," Williams wrote.

Applications such as machine learning highlight the need for new types of processors. IBM has benchmarked its neuromorphic chip called TrueNorth as being faster and more power-efficient than conventional deep-learning chips like GPUs.

Williams suggested ASICs and FPGAs (field-programmable gate arrays) could play a role in driving computing beyond Moore's Law. These technologies will use superfast interconnects such as Gen Z, which was introduced last year and will be supported by major chipmakers and server makers, including Dell and Hewlett Packard Enterprise.

Quantum computers are also emerging as a way to replace today's PCs and servers, but are still decades away from running everyday applications. ⊠

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Intel digs deep to keep Moore's Law alive

Intel is changing the way it measures process technology advancements, reveals Agam Shah

The landmark Moore's Law observation, which is now more than 50 years old, keeps shape shifting as the physical challenges of making smaller chips mounts.

Many scientists agree that Moore's Law is dying (page 15), but Intel is clinging on to it for dear life. It has been its guiding light for making chips smaller, faster and cheaper.

Now, the firm is changing the way it measures process technology advancements, which will help the company continue to boast about hitting key Moore's Law metrics in terms of economics and the shrinking of chip sizes. Primarily, the company is changing the way it measures logic transistor density, using a wider cell width.

"Moore's Law is not dead, at least not for us," said Stacy Smith, Intel's executive vice president leading manufacturing, operations and sales, during an event to talk about manufacturing in San Francisco recently.

At its heart, Moore's Law states that the cost of making chips goes down while the capabilities go up. Intel's interpretation of Moore's Law has changed multiple times. Initially, the chipmaker was doubling transistors every 18 months, which then expanded to two years. On its most recent 14nm process, that time line expanded to three years.

With the new measurements, Intel will be able to boast that its manufacturing improvements are surpassing Moore's Law. The company also said it would cut the manufacturing cost per transistor by half with each new manufacturing process, which is in line with Moore's Law.

But there are caveats to the new metrics. Intel is making multiple changes and introducing more chip architectures on each manufacturing process, and advancing to new processes at a slower pace.

Later this year, the firm will start making chips using the 10nm process, which is being projected to last for roughly three years. After that the company will move to 7nm, and Smith said there is 'visibility' to the 5nm process.

Rival fabs are now catching up with Intel, which had a manufacturing advantage for more than a decade. Samsung is making 10nm chips for mobile devices, with one example being Qualcomm's Snapdragon 835, though Intel says its latest 14nm chips are as

IMAGE: INTEL

good as the 10nm offerings from Samsung and GlobalFoundries.

The firm's reformulation of Moore's Law metrics is an attempt by the company to make up for lost time and a messy move to the 14nm process from the previous 22nm process, said Nathan Brookwood, principal analyst at Insight 64, who was at the event.

Manufacturing issues on 14nm in early 2014 meant Intel couldn't achieve the cost or transistor density it wanted. As the 14nm process matured, Intel started hitting those metrics, and had to press the restart button on its Moore's Law projections. Chip advances have also contributed to reconsideration of the metrics.

"There is an amount of reasonableness to it," Brookwood argued, saying Intel remains ahead of rivals on chip density. Intel has an advantage on gate and metal

pitches, giving its chips more density. Intel will continue to deliver new PC and server chip architectures every year, with a minimum 15 percent performance improvement per generation. Coming next will be eight-generation Core chips made on the 14nm process, an unprecedented fourth chip architecture on the process technology. Intel will also be releasing PC chips code-named Cannon Lake based on the 10nm process later this year.

That could create a scenario where the chipmaker has 14- and 10nm PC chips hitting the market at the same time. That could create issues in the branding of chips and confusion among buyers looking to acquire the latest and greatest Intel processors.

Earlier this year Intel said it will stress performance benefits to chip buyers, while playing down the role of process technology.

Intel's reformulation of Moore's Law metrics is an attempt by the company to make up for lost time and a messy move to the 14nm process from the previous 22nm process

For the past few years, Intel has moved away from the once-famous 'tick-tock' scaling, where new processes were 'ticks' and new architectures were 'tocks'. It is switching to what the company calls 'hyperscaling' advances, a new metaphor announced at the event to describe manufacturing advances. Intel will now use the '+' and '++' symbols to mark advances in the 14- and 10nm processes.

Hyperscaling will help Intel cram new architectural and process innovations without hurrying a move to a new manufacturing process.

New lithography techniques such as quad-patterning will help Intel take advantage of the economic benefits described by Moore's Law, explained Kaizad Mistry, vice president and co-director of logic technology development at Intel. That will improve transistor density, which also brings performance and power-efficiency enhancements. Intel is projecting 15 percent improvements in performance with each advance in the 10nm '+' and '++' processes. Intel will also reduce the chip size to pack I/O, logic and SRAM blocks into a much smaller area.

Intel is doing what the company calls "aggressive pitch scaling", which involves packing wires, transistors and 3D fins closer together. On the 10nm process, that helps provide transistor density improvement that is 2.7 times better than the 14nm process.

The chipmaker is also bringing the ability to mix and match different cores into an integrated system-on-chip. The cores could be made using different manufacturing processes. It's also much how ARM chips are designed and made, a process that integrates CPUs, modems, graphics processors and other cores into a single chip. ⊠

WikiLeaks: CIA used bits of Carberp Trojan code for malware deployment

The CIA's hacking operations allegedly borrowed elements from the Carberp financial malware when the code was leaked in 2013, writes Michael Kan

When the source code to a suspected Russian-made malware leaked online in 2013, guess who used it? A recent release from WikiLeaks claims the US CIA borrowed some of the code to bolster its own hacking operations.

In April, WikiLeaks released 27 documents that allegedly detail how the CIA customised its malware for Windows systems.

The CIA borrowed a few elements from the Carberp financial malware when developing its own hacking tool known as Grasshopper, according to those documents.

Carberp gained infamy as a Trojan program that can steal online banking credentials and other financial information from its victims' computers. The malware, which likely came from the criminal underground, was particularly problematic in Russia and other former Soviet states. In 2013, the source code was leaked, sparking worries in the security community that more cybercriminals might use the malware.

The WikiLeaks release includes supposed CIA user manuals that show the agency took an interest in the malware, especially with the way it can survive and linger on a Windows PC.

"The persistence method, and parts of the installer, were taken and modified to fit our needs," the US spy agency allegedly wrote in one manual, dated January 2014.

It's unclear why the agency chose Carberp. However, the borrowed elements were only used in one 'persistence module' meant for the CIA's Grasshopper hacking tool. That tool is designed to build custom

IMAGE: CIA

malware configured with different payloads, according to a separate document.

The WikiLeaks' release describes several other modules that work with Grasshopper to let malware persist on a PC, such as by leveraging Windows Task Scheduler or a Windows registry run key. However, no actual source code was included in the release. Nevertheless, the documents will probably help people detect the CIA's hacking tools,

which is WikiLeaks' intention in releasing the classified information.

In March, WikiLeaks began releasing a trove of secret files allegedly obtained from the CIA. Those first leaks described how the agency has a library of hacking techniques borrowed from malware out in the wild.

The US spy agency has so far declined to comment on the authenticity of WikiLeaks' document dump. ⊠

Cars will get superior digital vision with ARM's camera chip

ARM's Mali C71 image signal processor will help cars see obstructions. Agam Shah reports

Cars are turning into computers with a unique set of requirements. One of the more important components is a camera, which is a secondary feature in PCs. Cameras are aiding mirrors in allowing cars to self park, and they will serve as the eyes for autonomous cars, helping capture and analyse images.

The number of cameras on cars will only grow as drivers seek a better view of the vehicle's interiors and exteriors. For car makers, the next big goal is to bring context and understanding to those images. Combined with data from radar, lidar, GPS, and other sensors, cameras can help cars and drivers make better decisions.

ARM has come up with a specialised camera chip for cars, with the goal of bringing context to images and improving driver and passenger safety. The Mali-C71 image signal processor will analyse every pixel from cameras onboard a car, and much like a human eye, read the image, and help make driving decisions.

For example, today's cars are not good at identifying a person in view of the rear cameras when they are parking themselves. ARM's chip will be able to identify a person and stop the car. That's just the start – the chip will help identify people crossing the street as well as traffic signals and driving lanes in different lighting conditions.

The chip could also identify weather conditions, possibly with the help of information from GPS. That could help navigate safely through rough road conditions. A camera inside a car could also identify a drowsy driver and issue an alert.

A similar function could be performed by GPUs from companies like Nvidia that are targeting autonomous vehicles. But the ARM-based chips will be more power efficient, while GPUs are considered useful for more futuristic self-driving cars and may draw more power. Today's cars don't need full-blown GPUs for tasks like self parking.

The number of cameras in each car could exceed 10 in the coming years, and the reliance on them will only increase as cars go increasingly autonomous. The Mali-C71 supports up to four cameras in real-time. A car could have multiple Mali-C71s, and

vehicles with the cameras installed could start appearing as early as next year.

The Mali-C71 is aimed at cars with drivers at the wheel, though it has features that could be used in autonomous cars. It can support images in a 4096x4096-pixel range. Image signal processors aren't new and exist on mobile chips even today. But the Mali-C71 is different because of multiple reliability features to ensure pixels are reliably tagged and to ensure there are no data errors. A small error could mean an accident. The chip includes the features, image quality, and safety elements to be appropriately used in systems including simple backup cameras, multi-camera parking-assist systems, and even fully autonomous vehicles, an ARM spokeswoman said.

It can be used with ARM or other architectures, the spokeswoman said. Chips based on the ARM, x86, Power and MIPS architectures are all vying for a spot in cars. So are specialised ASICs, real-time chips and FPGAs (field programmable gate arrays). ⊠

Requirements
Home (£119): 1GHz processor or faster; 1GB RAM for 32-bit; 2GB for 64-bit; up to 20GB available hard disk space; 800x600 screen resolution or higher. DirectX 9 graphics chip with WDDM driver; Microsoft account
Professional (£219): 1GHz processor or faster; 1GB RAM for 32-bit; 2GB for 64-bit; up to 20GB available hard disk space; 800x600 screen resolution or higher. DirectX 9 graphics chip with WDDM driver; Microsoft account

★★★★☆

We just happened to have the camera ready to capture the new Windows Hello experience, as part of the Windows set-up process

SOFTWARE

Windows 10 Creators Update

Microsoft's Windows 10 Creators Update offers the most significant upgrade to Windows 10 since its launch, splashing a bright, cheery coat of fun over Windows 10's productivity foundation.

Price
This free upgrade is available now – new users will need to pay £119 for Windows 10 Home or £219 for Windows 10 Pro.

A cool new experience
If you're upgrading to a new PC equipped with the Windows 10 Creators Update, the new Cortana-driven, out-of-the-box experience (OOBE) is a charming introduction. Narrated almost exclusively by the actress Jen Taylor as Cortana, the OOBE is now voice-driven and almost entirely hands-free, orally asking you to agree to using Cortana, Windows' default privacy settings, and the like. In all, the set-up process took us about four minutes. You still have the freedom to toggle off targeted ads and other options, though Windows will immediately suggest a reason why you shouldn't.

You'll also notice a few thoughtful touches while bringing your PC up to speed. Adding a Logitech mouse to our test bed prompted Windows to search out Logitech's associated software. Device set-up now takes place behind the scenes, so Windows will notify you that you can use a new device within just a second or two. We also like how the Creators Update adjusts your display resolution or monitor set-up automatically instead of asking you to approve the process.

And then there's the "oh, wow" moments: Windows Hello
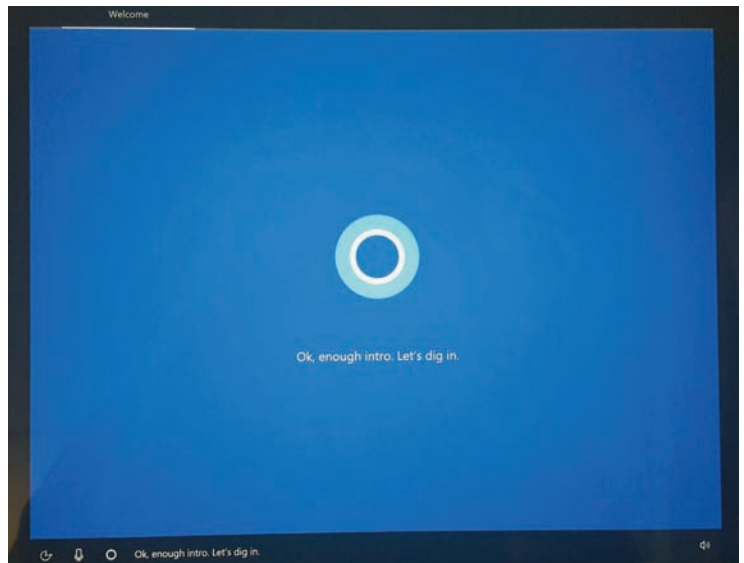
and Themes. Setting up facial authentication is done almost before you're aware it's taken place. Recognition is almost instantaneous, too. (We just wish there were a consistent way to sign in to multiple Microsoft services at once. Cortana offered to sign us into 'all Microsoft apps' within Windows, but it didn't take.)

Do not overlook Themes, either. For too long Windows has been shackled to generic default backgrounds. With the new Themes packs inside the Windows Store, you can get a glorious nature- (or cat-) inspired background, including optional sounds. Windows even displays different backgrounds on different monitors.

Setting up the Windows 10 Creators Update is now a pleasant, voice-driven experience with the cheery Cortana

Gamer gifts: Game Mode, Beam game streaming
Though Microsoft has invested heavily in the Xbox One game console (whose own Windows 10 Creators Update features are now live), Microsoft has made two key additions for PC gamers: Game Mode and Beam.

Remember when games like the original DOOM required tweaking HIMEM.SYS and other start-up files to eke out every last bit of performance? Game Mode does the same, but automatically, checking
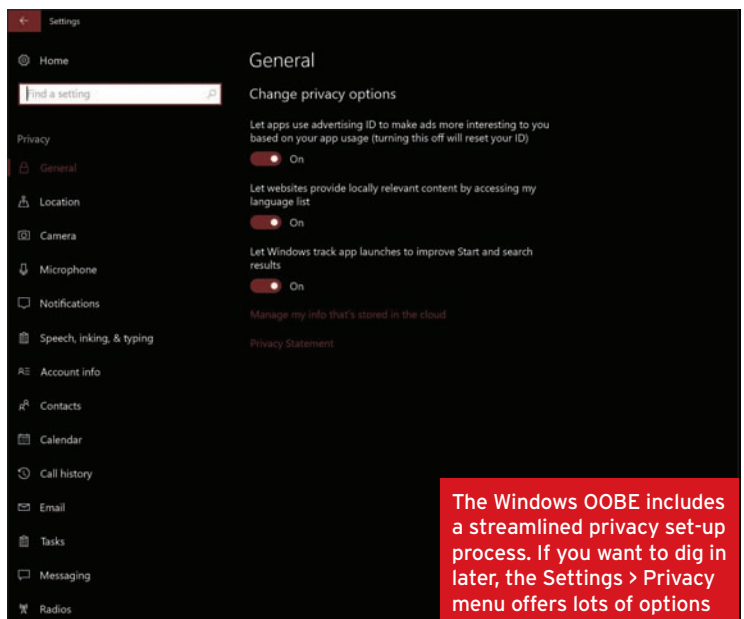
The Windows OOBE includes a streamlined privacy set-up process. If you want to dig in later, the Settings > Privacy menu offers lots of options
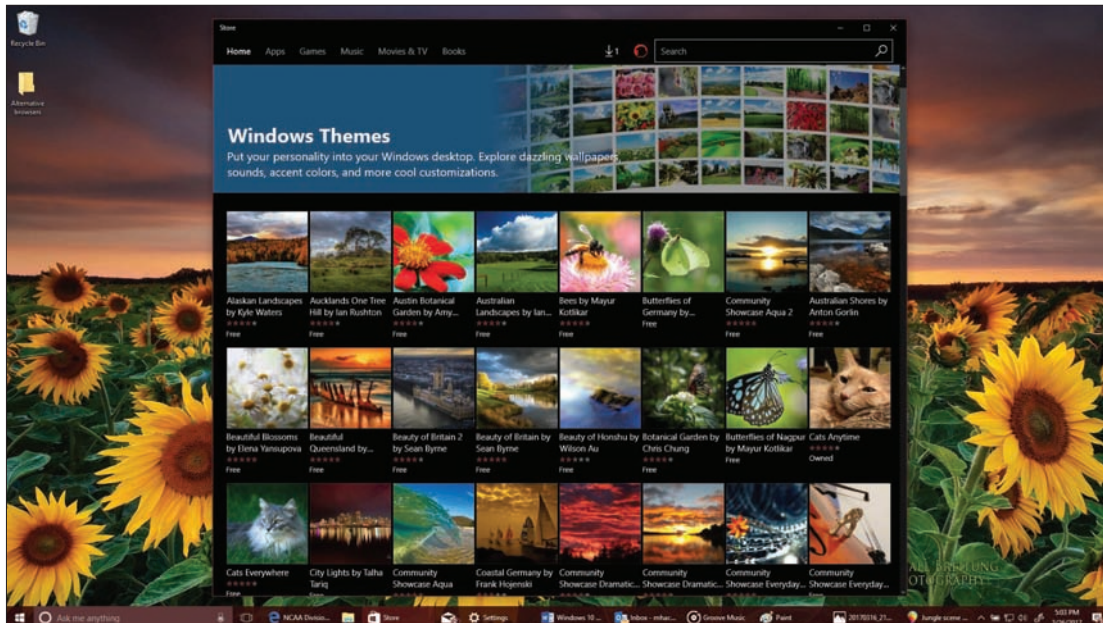
to see what other processes are running on your PC and giving your game application priority over them. The idea is less that you'll gain a few more frames per second, and more that games will run smoothly, without hitches and stutters.

If you're running a Titan X GPU, Game Mode isn't for you – laptops and desktops with low-end graphics will see the most benefit. But even those improvements could vary: we tried Game Mode with Microsoft's own in-house Gears of War 4 on a laptop with a discrete, but low-powered GPU. It showed just a small increase in minimum frame rate.

Last August, Microsoft bought Beam to gain some foothold against Amazon's Twitch and Google's

YouTube in the emerging world of game streaming. Streaming with Beam is pretty simple: open the Game Bar (Win + G, or the Xbox button on an attached controller) then navigate to the Broadcast icon. We had previously set up a Beam account on the website, but Beam never asked for it – it used our Xbox Live account name instead.

Streaming with Beam lets you play a game as an interactive performance, chatting with strangers about what's going on. Strangers may criticize, praise, or even pay you for your efforts. Beam's hardware impact may require further testing, though. In our raw benchmark scores, Beam streaming chopped quite a bit off of our laptop's CPU performance.

Windows Ink rejuvenates Photos and Maps

Microsoft had little to show for Windows Ink in the Anniversary Update. In the Creators Update, however, inking is actually fun. Within the Photos app, you can add ink annotations – comments, smiley faces, the works – and the ink will save to a separate copy of the file. Even set-up is smoother: as we were inking, Windows popped up a notification to set up the pen.

Inking saves an inked photo as a 'living image' within Photos, essentially a brief video where the ink spontaneously appears. (The above is just a plain-Jane JPEG.) Inking within videos is far more fun, as the ink will appear and disappear as the video plays.

Inking photos and video still needs some polish – the erase feature is all or nothing – and the feature cries out for some stickers or emoji, too. Add those, though, and Microsoft could regain some of the playful fun that's been missing from Windows from a decade.

One of the features Microsoft seems proudest of – inking two points within Maps, which then calculates the distance – we initially dismissed as useless. Tracing a footpath or stream and calculating the distance, though, has merit. (You can either use Ink's older straight edge – which now tracks angles – or a second, circular 'protractor' that helps draw arcs.) What Microsoft doesn't really make clear is that you can draw a similar line between two points, and Maps will then calculate the street route between them. That's much cooler, and something Google doesn't offer.

Paint 3D anchors a patchwork 3D experience

If there's one theme that Microsoft established during its autumn reveal of the Creators Update, it's that virtual – sorry, mixed – reality was central to the update. It's a shame, then, that much of it falls short. You may not even be aware that

Windows hides a robust suite of tools to import, create/edit, view, and print 3D objects: 3D Scan, View 3D, and 3D Builder all cooperate to provide a 3D content-creation toolchain throughout Windows. All of them were already there within Windows 10, and Paint 3D joins them with the Creators Update.

The Achilles heel here is 3D content creation. Last October, Microsoft promised – even demonstrated – a Capture 3D app that used a mobile phone camera to 3D-scan an object as easily as taking a movie. And where is it? Missing in action. Are 3D objects in Office? No. We spent hours with the built-in 3D Scan app, connecting a Kinect depth camera

to a Surface Studio and attempting to scan 3D objects, including this writer. Those attempts failed miserably, resulting in an 'object' that looked more like a puddle.

Paint 3D, on the other hand, is one of the triumphs of the Creators Update. It encourages you to create simple 3D objects with a variety of textures, or incorporate more complex objects from the Remix 3D community site.

From there, you can export your 3D object to Windows 10's existing, excellent 3D Builder app. The app neatly integrates a connector to a third-party 3D-printing service, which automatically imports your object and prices out its cost. But it's heartbreaking to come all that
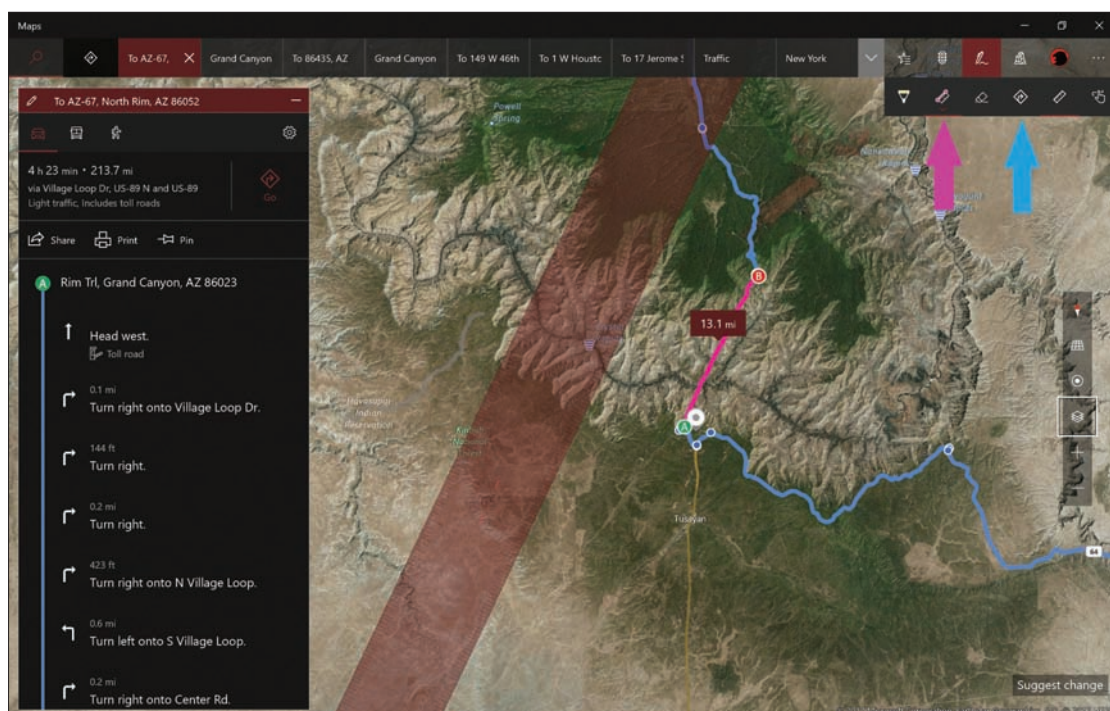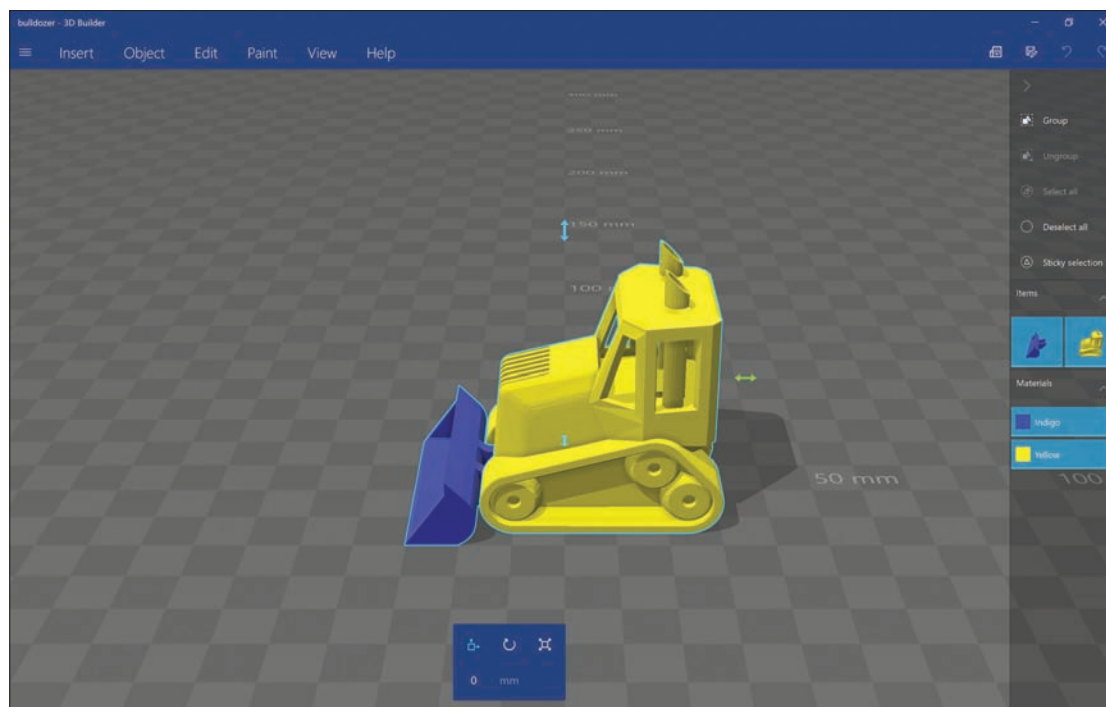
way and discover that the total printing price is probably much too expensive to justify the effort.

As for the HoloLens? Or the mixed-reality headsets Microsoft's talked up since last year? Both should serve as displays of sorts for virtual objects, yet neither is widely available. (Windows Mixed Reality, aka Windows Holographic, is available only for developers, we're told.) So far, Microsoft's VR promises are struggling toward viability.

Edge's new features include Netflix 4K, e-reading

Though many readers wrote off the bare-bones Edge that debuted along with Windows 10, it improved with the Anniversary Update, and the trend continues with the Creators Update. Here are the four key additions: the ability to import favourites from other browsers, new tools to organise tabs, Edge's debut as an e-reader, and its upgraded ability to play Netflix at 4K resolutions.

Reading books via Edge is functional, lacking some conveniences but offering a reasonable alternative to an app or an e-reader (see page 98). As for Microsoft's 4K Netflix claims – yes, we've proven they're true, and no other PC browser can say the same.

A new feature in Edge, the ability to set aside a tab or groups of tabs, is useful but needs refinement. Let's say that you began researching a trip to Hawaii, opened a few tabs on what to see or do in the islands, then called it a night. Normally, you might bookmark the tabs for a later date. Edge allows you to take that group of tabs and 'tombstone' them on the left rail. Each time you set the tabs aside, a new group is formed, which you can't label or add to, unfortunately. Each group of tabs can be reloaded whenever you want, even after a reboot. A somewhat related feature lets you preview tabs as thumbnails.

You can supposedly import favourites/bookmarks as well as passwords from the two most
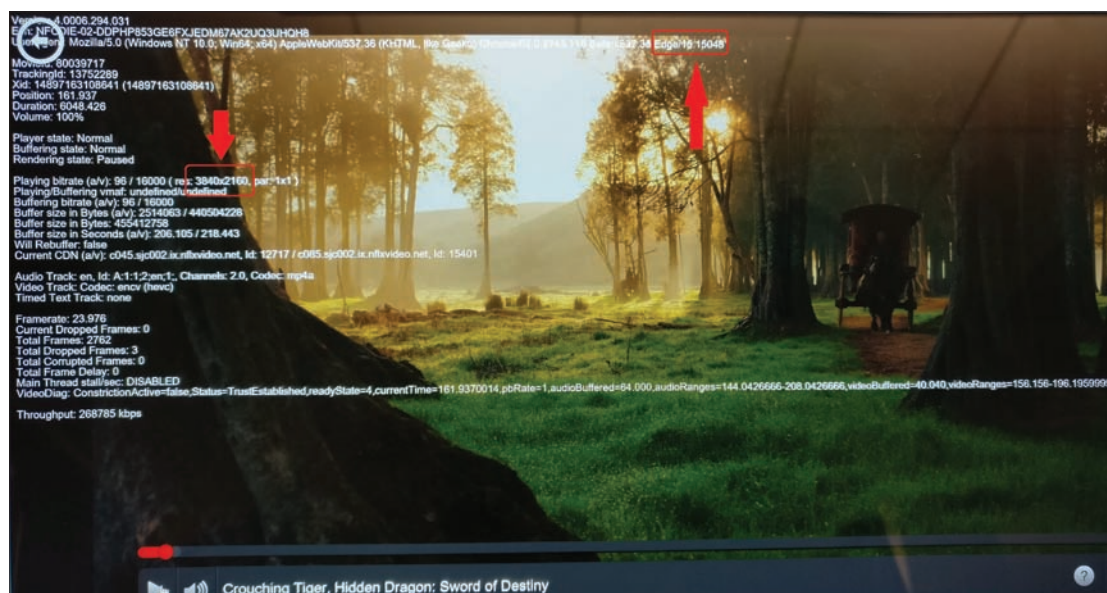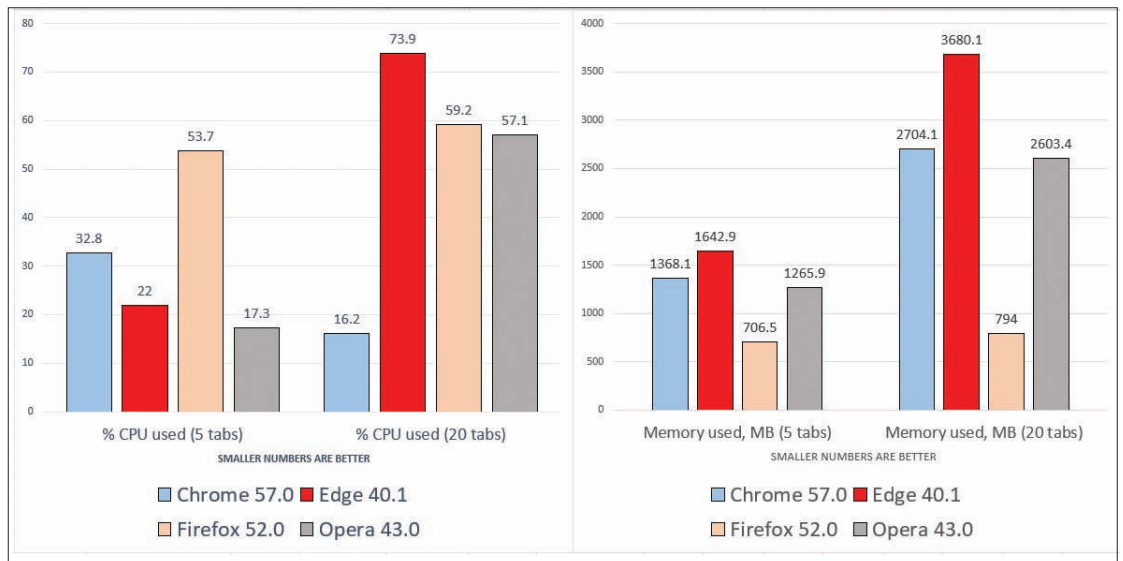
popular browsers, Internet Explorer and Google Chrome. At least with Chrome, bookmarks imported just fine, though we had to reorganise them a bit. Not a single password that we tested carried over, however.

We've been saying for a while now that Edge has risen to the level of a 'good' browser. Notably, it now boasts a total of 25 Edge extensions in the Store, including new additions like Microsoft Personal Shopping Assistant and Tampermonkey. But it remains an odd duck. It performs just as well as Chrome or Opera when loading a new web page, and it's nearly at the top of the class when browsing with just a few tabs. But under load, running 20 tabs, it slows down and bloats considerably.

Our benchmark tests show that Edge can simultaneously excel at calculating JavaScript operations used by Websites, but supply just half of the responsiveness of Chrome in certain web apps. In short, Edge meets everyone's expectations – good or bad.

Cortana gets its Groove on

Cortana's interactions have expanded from voice controls to the lock screen. Now, the Cortana full-screen experience launches any time she's idle. Because it normally hides in a narrow window in the corner of your screen, the full-screen experience is actually superior when displaying weather forecasts and maps.

This time around, Cortana's new features focus on music. If you ask her to play, say, "Paint It Black" by The Rolling Stones, it will launch Groove Music (if you have a subscription). Previously, it would import a YouTube video.

Cortana will also launch music from TuneIn and iHeartRadio, if those apps are installed. Here, though, you're subject to the whims of the apps; saying "play blues on iHeartRadio" prompted the app to play The Imaginary 8 The Girl's One Woman Blues Band, which isn't blues at all. You can also ask Cortana to identify what's playing – quite handy if you're listening to TuneIn, which simply streams local radio without any metadata.
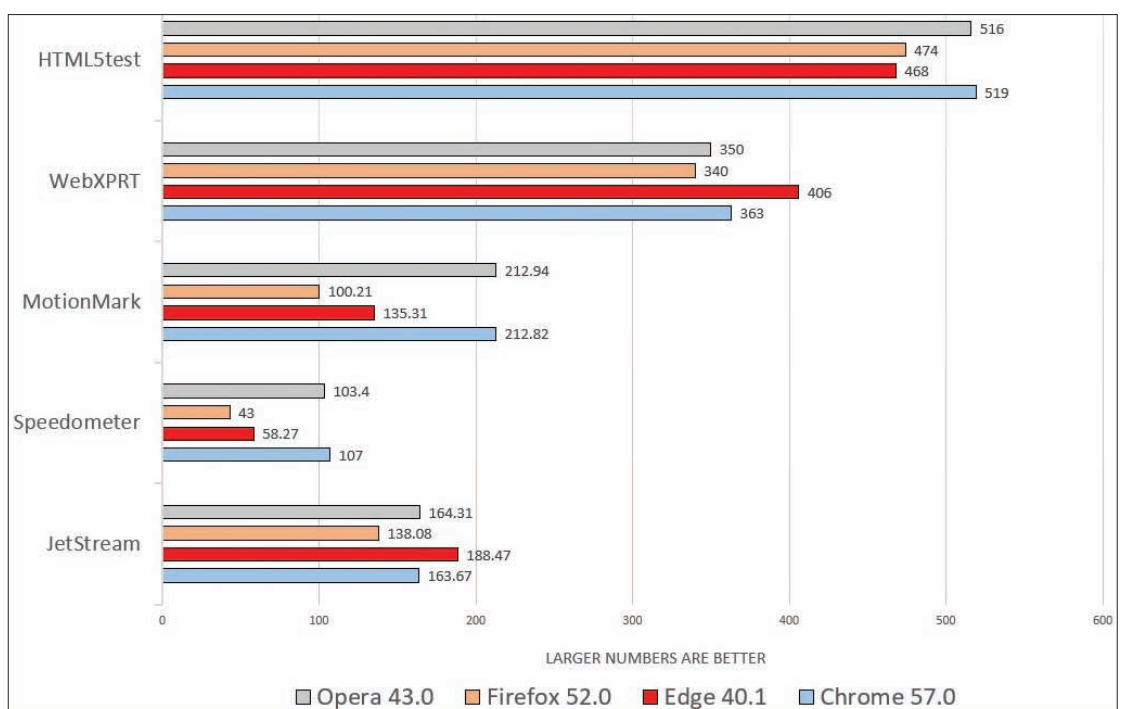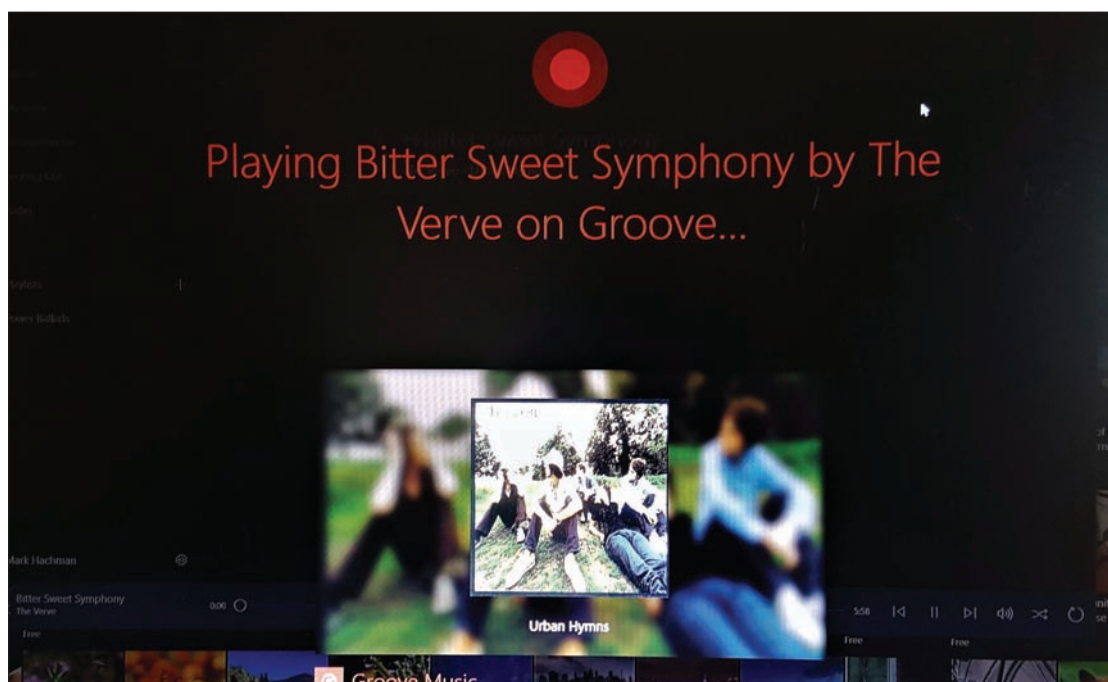
Playing Bitter Sweet Symphony by The Verve on Groove...

Cortana will also help you keep your commitments. If you've allowed it to read your Office 365 documents, don't be surprised to see it reminding you to live up to promises you've previously made.

Incidentally, Microsoft and Dolby have promised a Dolby Atmos app (with in-app purchases) that Dolby confirmed isn't live yet. A second option, Windows Sonic for Headphones, offers a virtual 7.1 surround experience that's a marked improvement over the vanilla audio that Windows offers – assuming you don't have a PC with audio improvements already included, of course.

The other improvements you'll care about

Though Microsoft unified the Creators Update around content creation and creativity, a number of piecemeal improvements made their way in, as well. An abbreviated list follows:

- Windows 10 CU includes a night-light feature that begins red-shifting your display's colour as the sun goes down, gently reminding your body that it's time to go to sleep. It helped eliminate my wind-down period before we went to bed.
- Ads for features such as OneDrive and Tips in Windows Explorer will drive some people absolutely crazy. Remember, though, that there are millions of users for

whom the new features will require some hand-holding.
- If you love macros and shortcuts, you're in luck: new touchpad settings allow you to craft your own gestures.
- If you have a precision touchpad (the Home > Devices >Touchpad Setting will tell you) you'll be able to configure your own touch gestures.
- PowerShell, a powerful yet slightly intimidating command interface, is now built into File Explorer.
- For those who need it, Windows' Narrator assistive technologies have significantly improved, with Braille support, a better Scan Mode, and assistance in resetting a PC.
- Keep exploring and you could find even more obscure but useful features, as we did, some of which just might become your favourites.

What's missing

If the Windows 10 Creators Update had worked out as Microsoft had promised, we all would be taking 3D selfies, importing them to Windows, and then sharing them among our closest friends and coworkers via Office presentations and mixed-reality headsets.

Microsoft sold us that vision as part of the Creators Update launch last autumn. But somewhere between then and the Creators Update roll-out, key pieces went missing. Microsoft previously said that its My People experience would

be left for the 'Redstone 3' update in the autumn. The company didn't warn us, however, that we wouldn't see the Windows Capture app, which creates 3D objects simply by tapping your smartphone. If there's a way to share 3D objects within the HoloTour app within the HoloLens, we haven't seen it. And, of course, neither the HoloLens nor the third-party mixed-reality devices are commercially available yet.

The ironic thing about the Windows 10 Creators Update is that, even lacking all that, it's arguably the most significant update since the launch of Windows 10. Those features that made it into the shipping code, including game streaming, e-reading, Game Mode, Beam streaming, Game Mode, and dozens more, collectively elevate the Creators Update.

Capture 3D, 3D PowerPoint, HoloTour

Over the past few weeks, we found ourselves obsessing over one simple statement. The very first feature that Microsoft introduced at its reveal of the Creators Update last autumn was this concept of 3D content. Microsoft's Megan Saunders walked on stage and declared that, in the Creators Update, "3D is for everyone".

"If we truly want to make 3D for everyone," she said, "then we need to make 3D creation as simple as taking a photo or a video on your phone."

Saunders then whipped out an HP Elite x3 Windows phone, launched what she called the Windows Capture 3D experience, and walked around a small model of a sand castle as the app seemingly constructed the 3D model, live, on her phone, in seconds. Voila: real-world object, Microsoft app, 3D construct. Cue the applause.

Watch the video for yourself at tinyurl.com/Ltku2er to see how simple Saunders made it look. Tell us that app doesn't look ready to ship, especially as she seemingly uses it live on stage. But no, it's

not available. Was Saunders' performance sleight of hand? A movie? Did Microsoft hold back Capture 3D until it could be ready on Android and iOS as well? Microsoft hasn't said.

What makes that statement so important is that, Paint 3D aside, scanning real-world objects into Windows is almost ludicrously difficult. (Unless you're using an HP Sprout.) You'll need Microsoft's 3D Scan app, a PC with a decent GPU, a Kinect depth camera, a massive adapter, some sort of rotating table, a tutorial, and a great deal of

patience. We spent several hours, muttering and cursing, and got something that looked like a flying saucer falling to bits. Brian Posey, a Microsoft MVP, tried out 3D Scan and gave up halfway through.

It goes on from there. As part of the launch event, Microsoft's Heather Alekson introduced the ability to import 3D objects into PowerPoint and other Office apps. To date, that feature isn't available either in Office or in the Office Insider program. Paint 3D within the HoloLens? Importing 3D objects into the virtual space? Neither,

recover. You know these names: Half-Life 3, Duke Nukem Forever, HD DVD, StrongARM, the Itanium chip. Market demands change.

Simply excluding My People or Capture 3D or Arenas from the Creators Update certainly doesn't mean that we'll never see them again. We're betting we'll hear much more about mixed reality in a month or so at Build, as a run-up to Windows' next major update this autumn.

Verdict

We can't say for certain how stable the Creators Update will be, though we noticed far fewer bugs than in preceding iterations. Microsoft Word had an issue with opening a file stored on OneDrive, and the helpful Tips app still referred to Anniversary Update content in our Creators Update build.

What angers us, though, is how far removed the Creators Update is from the vision Microsoft presented in the autumn, especially when it comes to 3D content. "If we truly want to make 3D for everyone, then we need to make 3D creation as simple as taking a photo or a video on your phone," Microsoft's Megan Saunders promised us then.

It's not. It's not even close to that. There are so many features that Microsoft pledged and has yet to deliver on: apps to capture objects as 3D images, the My People experience, 3D objects in Office apps, mixed-reality devices from its partners. Windows Holographic, renamed Windows Mixed Reality, is present, Microsoft says, though available only to developers.

If Microsoft had nailed 3D content in the Creators Update, our rating would have been higher. We can't help but think that Microsoft should have announced two Creators Updates: one now, and one scheduled for the autumn.

Is the Creators Update worth your time? Yes, absolutely. Microsoft's creative vision enumerated inside the Creators Update remains potent and viable, though also unfulfilled.
⊠ **Mark Hachman**

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apparently, is here. Microsoft tells us that: "Windows Mixed Reality [formerly known as Windows Holographic] will be available on Windows 10 PCs with the Creators Update so that developers can start creating content," implying that regular users will have to wait for access.

We can't ignore the lack of mixed-reality devices, either. Yes, the responsibility for delivering mixed-reality devices on time for the launch of the Windows Creators Update falls on hardware partners like Acer, Asus, and Dell. (Did Microsoft's Terry Myerson promise mixed-reality devices by the Creators Update launch? Decide for yourself.) But Microsoft has developed its own hardware for years, and has a tight working relationship with each of these vendors. 3D-capable, mixed-reality hardware was part of Microsoft's 3D vision, and it hasn't been delivered.

The gaping holes in Microsoft's 3D vision overshadow everything else Microsoft promised last autumn. But a number of other features Microsoft promised for the Creators Update haven't appeared, either.

My People

Microsoft already quietly announced that it's postponing the My People experience. My People, which sounds like it might be either replacing or supplementing the existing People app within Windows 10, will allow you to pick five close friends or family members and customise your experiences around them – putting icons in the taskbar, auto-suggesting them as email contacts

and to chat, and allowing them to send you emoji via what Microsoft calls "shoulder taps".

Microsoft, though, plans to hold My People for "the next major update to Windows," which is due out in the autumn.

Xbox Arenas

One of the features Microsoft showed off in the Xbox gaming space was Arenas, player-configured tournaments. "The Xbox team is still working hard to bring custom gamer-created Arena tournaments to the Xbox community, though it will not be releasing alongside the Windows 10 Creators Update," Microsoft said in a statement.

Groove Music Maker

Though it was never officially announced, the Groove Music mixer app appeared in a 'sizzle reel' of other features at the launch itself, as well as Microsoft's general Windows 10 Creators Update video. We haven't seen it in the update itself, nor the Microsoft Store.

Tabs as Reminders

One of the smart features that Microsoft added early to the Windows 10 CU was the ability to tie an Edge tab to a Cortana reminder, a handy jumping-off point to research a wedding cake, explore potential campsites, or dig through tax regulations. In November, though, the company cancelled it.

We're aware that companies over-promise and under-deliver, delay products and cancel commitments. Sometimes they just slide into a niche and never

Specifications
13.3in (1920x1080, 165ppi) IPS LCD glossy; 1.3GHz Intel Core i7-7y75 (3.6GHz boost) 2 cores, 4 threads; Windows 10 Home 64-bit; Intel HD 615 GPU; 8GB 1866MHz DDR3 RAM; up to 512GB SSD; 802.11b/g/n/ac single-band 2x2 MIMO; Bluetooth 4.2; 2x USB-C 3.1; microSD slot; Kensington Security Slot; stereo speakers; HD webcam; single mic; 3.5mm headset jack; UK tiled keyboard with numberpad; two-button trackpad; 46Wh lithium-ion battery, removable; 304x199x13.7mm; 1.24kg; 1-year onsite warranty

LAPTOP
Dell XPS 13 2-in-1

Build: ★★★★½
Features: ★★★★☆
Value: ★★★☆☆
Performance: ★★★★☆

★★★★☆

Dell is no stranger to peaks and troughs when it comes to being in fashion. Luckily, it's a brand that's in the ascension once more, helped by a subtle rebranding and excellent products to match. This rise has been greatly helped by the excellent XPS 13, one of the best Windows laptops in the world. The firm's latest update to the range, the XPS 13 2-in-1, is a convertible touchscreen version. With tablet functionality and the option to use the Active Pen, it continues to help Dell blur the lines of its target market.

Price
Dell offers four configurations of the XPS 13 2-in-1, maxing out at £1,669 for 512GB SSD with a Core i7 and 8GB RAM.

Design
This is one of those products that begs to be touched

and used. The design is stunningly thin, yet the right side of substantial, with a metallic frame and plastic detailing in all the right places.

The 13.3in InfinityEdge display has incredibly thin bezels. Indeed, Dell claims the unit is actually the size of an 11in laptop when closed. This is a bit of a stretch, but it's certainly one of the most compact 13in models out there measuring 304x199x13.7mm. During our time with the XPS, we were able to perch it upon our knee on our commute.

The chassis also houses a microSD slot, two USB-C ports, a lock slot and a headphone jack. The whole thing, when closed, has an elegant taper to it, with a professional blend of silver and black colours. The presence of the soft finish of the body when opened also helps to add to the premium look and feel of the laptop.

Unlike the 13in MacBook Pro, the Dell keeps traditional scissor mechanism buttons on its full-size keyboard. There are, however, two hinges that let you spin the screen around and use the unit as a tablet. As the dimensions of the screen are laptop-size, you probably won't find yourself using it in portrait mode, but in landscape mode you can take advantage of the touchscreen and Active Pen (sold separately for around £80).

You may not use it as a full-on tablet, but the fact the option is there, along with pen input, is all the more attractive when Dell has achieved it without compromising the usability of the device as a traditional laptop.

Like the firm's other XPS models, the build quality is great. The screen doesn't bend easily under pressure, there's almost no flex to the keyboard and even when you pick the laptop up by one edge, it doesn't feel like you're mistreating it.

If you're going to spend as much time using a laptop on the road as in the office or at home, the XPS 13 2-in-1 is a perfect fit.

Features
Dell's laptops are extremely flexible when it comes to specifications and customisation. The entry-level model ships with a seventh-generation Kaby Lake Intel Core i5 processor, 4GB RAM and 128GB solid-state storage. It's good to see the firm opt for Intel's latest chips, though these are the low-voltage versions.

Also on-board is an Intel HD graphics card, a widescreen HD

(720p) webcam with dual mics, 802.11ac 2x2 Wi-Fi connectivity and powerful stereo speakers. There are two cameras that sit oddly at the base of the screen (due to the InfinityEdge display) that are Windows Hello-ready (the tech that allows for retinal security identification). Bar the still debatably annoying lack of a USB-A port or full-size SD slot, this laptop won't disappoint with the functionality on show compared with other barer ultrabooks on the market.

Display

There are two screen options when you buy an XPS 13 2-in-1: a 1080p display or a more pixel-dense QHD+ one with 3200x1800 pixels. This is the 'step below' 4K, and there's an argument to be made that 4K in a 13in laptop is overkill anyway.

Dell sent us the 1080p version and, consistent with it being the cheaper option, its performance is very good if not quite world-beating. To the naked eye colours look well-saturated and fairly deep, but our colorimeter tells us it actually only covers 85.6 percent or sRGB, 61.6 percent of Adobe RGB and 64.2 percent or DCI P3.

Graphics professionals who need wide colour gamut coverage should check out the QHD+ version or something like the 4K Razer Blade Stealth, which has incredibly rich display colours. We don't think anyone else needs

to worry, though, particularly as the good 1100:1 contrast keeps the screen looking punchy.

The backlight maxes-out at 305cd/m^2, which again isn't a class-leading statistic, but was enough to let us use the Dell XPS 13 2-in-1 out in the park to write some of this review. It does use some potentially annoying auto brightness management you can't switch it off, but that's probably more an annoyance to laptop testers than real people.

Performance

Perhaps the most serious reason to consider not buying the XPS 13 2-in-1

outside of its price is the kind of processor it uses. All versions have Core i-series processors, but they are Intel's Y-series ones.

These are the most power-frugal of Intel's premium laptop chips, with less raw power on tap than the corresponding U-series Core i5 or i7. U-series chips are what you'll find in the majority of thin laptops, as only ultra-ultra skinny ones tend to use the kind seen here. You may have bumped into them before when they were called 'Core M', in previous generations.

The good news is that for everyday use and general productivity tasks, one of these

Y-series chips won't feel obviously slower than a quad-core desktop-grade CPU. They're fast, Windows feels responsive and they even perform well in most benchmarks.

Our review model has a Core i7-7y75, and it scored 6906 in Geekbench 4 and 2558 in PCMark 8. This is the sort of score you might get out of a 'normal' Core i5 laptop CPU, but efficiency and small size are the real aims of this kind of processor.

For our sort of day-to-day usage, which at its most taxing involves Photoshop editing of large images and a bit of light video editing, it's absolutely fine. If, however, you're regularly going to be maxing-out the CPU, you might want to find something with a bit more power.

The Dell XPS 13 2-in-1 is also poor for gaming, as the Core i7-7y75 has a much worse graphics chipset than the Core U-series ones seen in the normal XPS 13. Where we can normally make our standard test games, Thief and Alien: Isolation just about playable at 720p with graphics settings chopped down, we struggled here.

At minimum settings, 720p, Thief runs at 15.6fps, dropping to a painful 4.9fps when we switched up to 1080p, high settings: how you'd want to play the game ideally. Alien: Isolation runs at 20.8fps at 720p, and 9.3fps with the resolution at 1080p and the graphical quality increased. None of these results are playable unless you have very low standards.
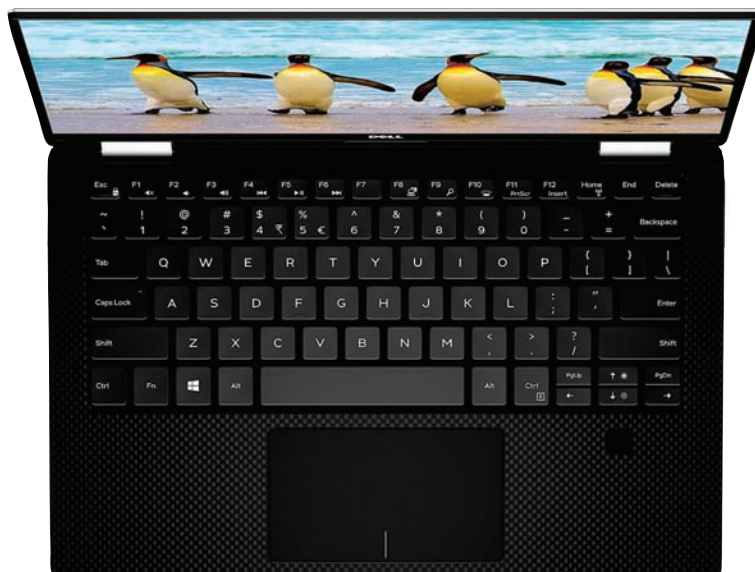
If you care about laptop gaming, you probably shouldn't buy the Dell XPS 13 2-in-1. However, we could have told you that from a quick look at the specifications.

One benefit of the high-efficiency brain is that it doesn't need fans, so is silent 24/7. After a few hours of testing, the rear of the underside had become a bit warm, but not worryingly so. There appear to be no issues with heat management here.

Battery life

The main benefit of the CPU style is battery life. While this model has a much smaller battery than the normal Dell XPS 13, with 46Wh to the non-hybrid's 60Wh, stamina is still very good.

Playing a video on loop, it lasts 10 hours 13 minutes, at 120cd/m² brightness – enough for all-day use. It runs longer with light use still, but it comfortably outlasts the HP Spectre 13 and Asus ZenBook 3.

Software

It ships with Windows 10 Home, which works well in tablet mode but is exceptional in laptop mode.

Windows has refined it in the latest Creators Update. We found it to be an easy match for the MacBook/macOS Sierra combination as well as any other PC out there running Windows 10.

With Windows Ink, you can use the Active Pen to take notes, annotate documents and explore the newer creative features of Windows 10. We must admit that if you are keen to fully embrace digital note taking or illustration this isn't the machine for you (try the Microsoft Surface Pro 4 or the Lenovo Miix 720), but the ability to be able to use those functions while still investing in a fully-fledged laptop will make the XPS a tempting choice for some.

Verdict

The XPS 13 was already excellent, and it's a smart move from Dell to release this hybrid edition without compromising the design and functionality of the original vision. The XPS 13 2-in-1 is an ultrabook that will fit in to any home or work environment. The thin bezels, excellent keyboard and thoughtful design are marred only by a high price. The hybrid form is well-executed too, although it's worth considering about whether you'll appreciate a folding touchscreen when it comes at a premium. Then again, this is the future. ⊠ **Henry Burrell and Andrew Williams**
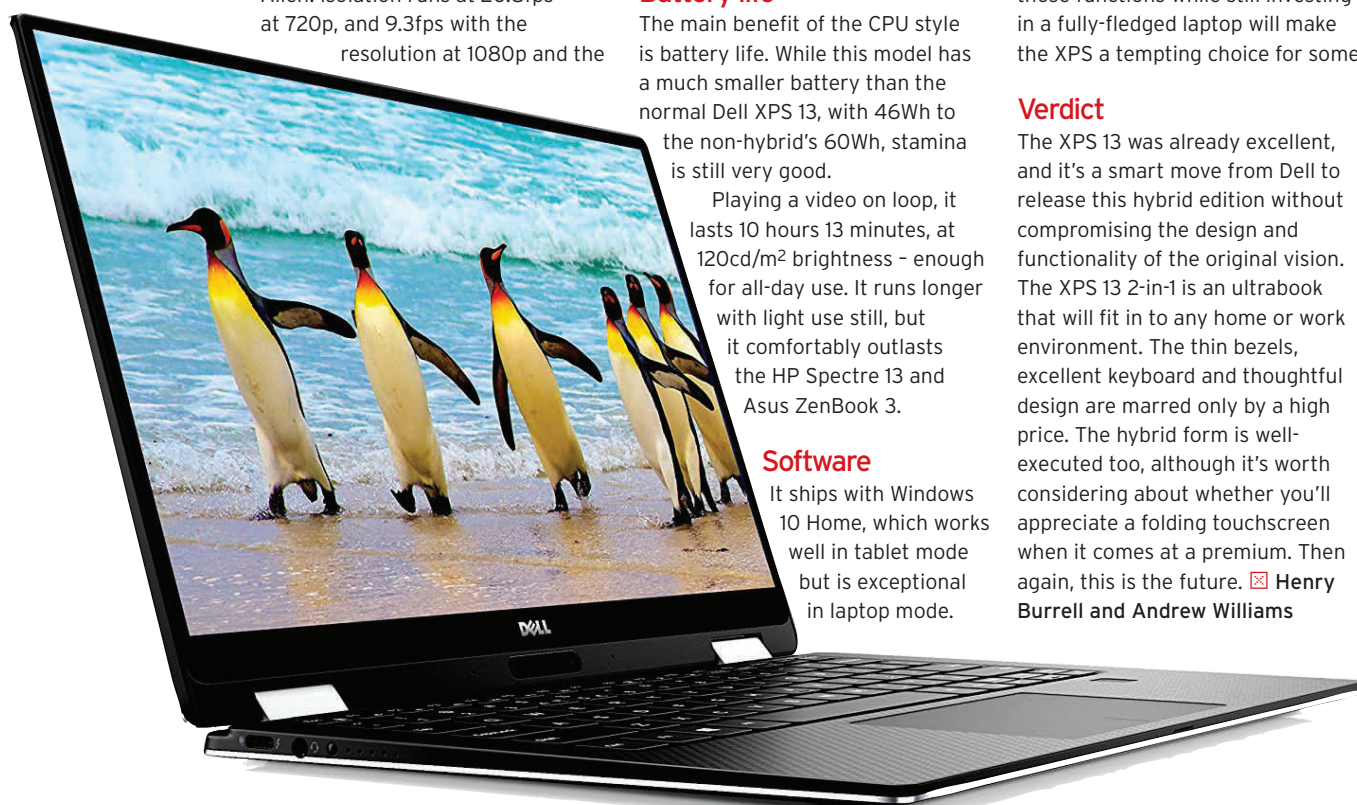
Specifications
17.3in (1920x1080, 127dpi) IPS matt anti-glare; Windows 10 Home 64-bit; 2.3GHz Intel Core i5-6300HQ (3.2GHz boost) 4 cores, 4 threads; Nvidia GTX 1060 6GB GPU; 8GB 2133MHz DDR4 RAM; 1TB 5400rpm SATA HDD; 802.11b/g/n/ac single-band 2x2 MIMO; Bluetooth 4.1; USB 3.1-C port; 3x USB 3.0 port; RJ45 LAN Ethernet; HDMI; Thunderbolt compatible mini Display Port; SDXC card slot; stereo speakers; HD webcam; single mic; 3.5mm headset jack; backlit UK-tiled keyboard with numberpad; two-button trackpad; 76Wh lithium-ion battery, non-removable; 415x280x24mm; 2.7kg

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★½
Performance: ★★★★½

★★★★½

LAPTOP
Asus ROG Strix GL702VM

PC ADVISOR RECOMMENDED

The Asus ROG Strix GL702VM is the kind of laptop you need if you're a serious gamer, but don't have the cash to spend on the very best processors and graphics cards. It's not cheap, but is far less expensive than the latest MacBook Pro.

Don't think it's riddled with compromises either: its Nvidia GTX 1060 is significantly more powerful than the previous-generation GTX 980M, and you'd have to spend almost £2,000 to get a laptop with one of those.

Price
You can buy the entry-level Asus ROG Strix GL702VM for £1,129 from Amazon. As we're talking about a gaming PC, and one released as the pound if weak, that only gets you mid-grade core specifications. It has a high-power variant of Intel's Core i5 CPU, 8GB RAM, a 128GB SSD and 1TB hard drive. You may find gaming laptops with more RAM and a faster CPU at a similar price, but to buy one would probably be a mistake. For gamers, GPU power means more than almost anything else.

Asus also offers a higher-end version of the GL702VM that upgrades the RAM to 16GB and the CPU to an Intel Core i7. It costs £1,349, a £150 upgrade. Both variants come with a one-year collect and return warranty.

Design
For the past couple of years, Asus's G752-style laptops have provided models easy to recommend. The ROG Strix GL702VM we're reviewing here isn't necessarily worse, but it is quite different.

This is a much slimmer and lighter laptop than the G752. This makes handling heat and noise trickier, and leaves the GL702VM with a shallower keyboard, but many people may find this laptop far easier to live with.

Its 17.3in screen will seem imposing if you're used to 13in models these days, but its weight and thickness are not. At around 2.7kg, it's too heavy to carry around all day, not to mention too large to fit in most rucksacks. However, moving it from room to room isn't something to dread, which can be the case with some 4kg gaming beasts.

That's not to suggest the GL702VM is ashamed of its gaming habit, though. The slimmer frame rules out any truly outlandish fan outlets, but you do get plenty of

flourishes from Asus's Republic of Gamers (ROG) series handbook.

The logo and a pair of decorative slashes into the lid light-up red, as does the keyboard backlight. There are similar non-lit flashes of red on the keyboard itself, and even the underside.

Typical of almost all high-end gaming laptops, the GL702VM has a metal lid but the rest is plastic. There's a brushed-like finish to the keyboard surround, but the main design intent here is moody-looking red on black. No-one is trying to pretend this is a gaming ultrabook.

Connectivity
The Asus doesn't have an optical drive, which you will still find on the firm's largest gaming laptops, though connectivity is comprehensive. The sheer breadth of sockets a laptop has to include to get this coverage is significant. On the left side are a mini DisplayPort with Thunderbolt, HDMI, USB-C an Ethernet ports, and a USB 3.0. On the right are two additional USB 3.0 sockets and a full-size SD card slot.

Keyboard and touchpad
There's a well-spaced but fairly conventional laptop keyboard,

without the extra travel seen in heavy-duty gaming laptops like the Asus G752 and Alienware 17. Key action feels high-quality and there's a pleasant resistance to the keys, but predictably slightly shallow. We find it comfortable to type away day-long on, though, and anti-ghosting tech lets you tap keys as fast as you like without any missed presses.

It has a red backlight, matching the other bits of flair on the laptop. If you're in a situation in which you can't use the light, the WSAD keys are bright red to make them stand out even if lighting is poor. Necessary? Probably not, but as Asus bothered making this move someone must have asked for it.

The GL702VM's large 17in frame also provides room for a full numberpad, although the row of dedicated macro keys seen in some of Asus's largest laptops is absent.

Similarly, the trackpad is fairly conventional. It's relatively small for a laptop this large, but no gaming laptops have huge trackpads, under the assumption many will plug in a mouse anyway.

The trackpad's surface is very smooth, and uses integrated buttons that aren't too noisy or difficult to click. However, in its current state does have an

annoying driver issue that causes the cursor to leap across the screen at times, seemingly a result of too-high sensitivity confusing the presence of a second finger for a swipe. Be prepared to have to fiddle around with drivers and/or Windows 10 settings to get the GL702VM's pad working as intended.

Display

With a 17.3in display, the screen doesn't look anywhere near as pixel-packed as some of trendier slim and light laptops found at this price. However, this is still arguably the best resolution for the machine.

Its graphics card can handle some demanding games at QHD resolution, but for 4K gaming you'll need more power than this laptop can provide.

This is an IPS LCD display with a matte finish, turning reflections into much more diffuse, much less distracting, splodges of light.

Display quality is very good, if not quite among

With a 17.3in display, the screen doesn't look anywhere near as pixel-packed as some of trendier slim and light laptops found at this price

the very best laptop screens. Its top brightness, for example, is 320cd/m^2 where we recorded 380cd/m^2 from the Asus G752. The GL702VM's is less searing, but as these laptops are unlikely to be used outside in bright sunlight often, its no big deal. 320cd/m^2 is still pretty bright.

Contrast, too, is a little below the 1000:1 we like to see in a top-end laptop at a solid 812:1. Like other matte-finish laptops, you'll notice this as a slight blue tint to the screen's backs when the backlight intensity is high.

Colour performance is good but not standard-setting, covering 85 percent of the sRGB colour standard. We'd be hard-pressed to notice any undersaturation with our eyes, though, particularly as the GL702VM's screen also covers colours outside the sRGB spectrum, too. For those into screen performance, it covers 62.4 percent of Adobe RGB and 71.9 percent of DCI P3.

If our reception of the screen sounds lukewarm, it's only because it's roughly what we expect of a high-end laptop. It's still a very capable display.

Performance

The screen has the chops to fit in with its high-end rivals, but in the variant we're using at least, the GL702VM has a real mix of entry-level and high-end hardware.

8GB of DDR4 RAM and a 128GB SSD are the minimum you'd want in a system this expensive. There's a 1TB hard drive too, but as it's so much slower than the SSD you may

be left juggling games to keep your most-played ones on the solid-state storage. Games installed on the SSD will load quicker.

The CPU is similar. It's a Core i5-6300HQ rather than an i7, generally favoured in gaming PCs. It's a quad-core CPU, so still faster than the dual-core i7 processors you'd see in a £1,200 to £1,400 ultrabook, but as our gaming tests show, the extra CPU power may be worth the upgrade.

Running the built-in Thief benchmark, the CPU actually bottlenecks performance, managing an average 66.4fps at 1080p ultra settings, and 75.5fps at 720p, low settings. This is to an extent a quirk of the benchmark, which is very CPU-intensive, and the fantastic results when playing Alien: Isolation are more indicative of how good a gaming machine this is.

Alien: Isolation runs at a blistering 197fps at 720p, low settings and a, well, still-blistering 135fps at 1080p max settings. This is significantly faster than the results of the first GTX 1060 laptop we reviewed, presumably because the drivers have improved so much since launch.

For most gamers who want a 1080p laptop, the Strix GL702VM is exactly the sort we'd recommend. GTX 1070 and GTX 1080 laptops are eye-wateringly expensive, and their power only currently useful in models with screens of resolutions in excess of 1080p.

It's difficult to overstate how much better the GTX 1060 is than last year's GT 960M. Not only are the new laptop cards much closer to their desktop counterparts than before, Nvidia also made huge performance strides more generally with the Pascal generation.

Despite holding the Thief test back, the Intel Core i5-6300HQ processor is also very capable. It's more powerful than the CPU of the £2,000 MacBook with Touch Panel, for example. You can edit video with this laptop. It scored 9393 in Geekbench 4, and you can expect a score around 12,000 points from the Core i7 £1,349 version.

In PCMark 8 it scores 3633 points – a great result for an Intel Core i5 machine.

One consequence of a relatively slim frame, considering the powerful GPU, is that at times of strain the fans have to work quite hard. Most of the time the Asus ROG Strix GL702VM is near-silent, and give out a fairly light inoffensive whoosh during light gaming. After a while, the underside and area above the keyboard get warm, eventually spreading into the keyboard itself, but no parts became worryingly hot during testing.

However, max the system out and after 10 minutes or so the fans do kick up to a higher gear. There's no high-pitch whine, but the noise is noticeable.

Audio

The speakers do have a chance of competing with it, though, thanks to a bulky, thick tone. There's more bass than the average, and a smooth mid-range that's better for games and movies than a bog-standard thin laptop speaker.

Treble clarity is limited, mind, making the GL702VM sound quite sultry and dark next to something like the MacBook. At times we were also left wishing for 10- to 20 percent extra volume, but we imagine many of you would use a headset or headphones for any serious gaming anyway.

Battery life

The use of an HQ-series CPU rather than a low-power U-series one instantly tells you this laptop's battery life is not going to be stellar. However, it is still better than some gaming laptops, lasting four hours 55 minutes when playing a 720p video on loop at 120cd/m^2 screen brightness.

That's fairly good for a laptop not designed for ultra-portable use, enough to last for long meetings, train journeys or whatever reason you might have for needing to be away from the plug for a while.

You won't get that sort of stamina when gaming, though. Expect around 90 minutes when the laptop is maxed-out or close to it.

Verdict

We have just one issue with the Asus ROG Strix GL702VM: its trackpad does some strange things, most likely because of driver issues. Operating under the assumption that this can or will be fixed, this is a great gaming laptop. It's not incredibly expensive by today's standards, but still gets you desktop-grade gaming power, a good display, solid build and fair battery life. Thanks to the great power of Nvidia's latest laptops graphics cards, this could well be the only gaming machine you need. And this particular one is hundreds cheaper than some others using the same GPU. ⊠ **Andrew Williams**

Specifications
15.6in (1920x1080, 141ppi) IPS LCD touchscreen; 2.7GHz Intel Core i7-7500 (3.5GHz boost) 2 cores, 4 threads; Windows 10 Home 64-bit; Intel HD Graphics 620; 16GB 2133MHz DDR4 RAM; 512GB SSD; 802.11b/g/n/ac dual-band; Bluetooth; 2x USB 3.0; 1x USB 2.0; 1x USB-C HDMI; Ethernet (via included USB-C to RJ45 adaptor) Kensington Security slot; Micro-SDXC card slot; stereo speakers; HD webcam; dual mic; 3.5mm headset jack with DTS Headphone X processing; tiled backlit keyboard with numberpad; two-button trackpad; 60Wh lithium-ion battery non-removable; 358x228x15mm; 1080g

Build: ★★★★☆
Features: ★★★★☆
Value: ★★½☆☆
Performance: ★★★★☆

★★★½☆
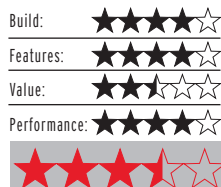
LAPTOP
LG gram 15

When you think about a full-size 15in laptop, the word portability doesn't spring to mind, but LG has sought to change that with its latest incarnation of the gram 15, now with the seventh-generation Intel Kaby Lake processors for 2017.

Price
LG sells two versions of its laptop, priced £1,679 for the Core i5 model (15Z970-U.AAS5U1) and a whopping £2,099 for the Core i7 (15Z970-A.

AAS7U1). Each runs Windows 10 Home 64-bit. While that might still be cheaper than the latest MacBook Pro with Touch Bar, which fetches £2,699, the excellent Dell XPS 15 with similar specs costs £1,599.

Design
Like a lot of the laptops we've seen this year, the design remains the same as its predecessor since only the processor has been updated.

As its name suggests, the gram 15 is all about weight. It's somewhat surprising that this laptop, despite offering a 15.6in screen, weighs only 1080g. Not quite under the 1kg mark but at just over, it's around half the weight of the XPS 15.

This is achieved by it being slightly thinner at 15mm, compared to the Dell's 18mm, but mainly due to the metal alloy body, which LG says is made from 'advanced nano carbon with magnesium'. It's doesn't feel like metal to the

touch, much more like plastic, but the laptop is so light that we don't mind. The screen is flimsy and bends very easily, though the material appears to be scratch resistant.

The XPS 15 might look and feel more premium, but if you're looking for a 15in laptop that won't bog you down, then you won't find anything lighter than the gram 15.

This LG is also around the same size as the Dell thanks to a very slim bezel around the screen – just 5.5mm at the sides – making it not only good to look at but feel like a smaller laptop. It's a good idea to integrate the webcam into the hinge below the screen, though the angle of the camera doesn't always work with how you want the screen; and you can't adjust them independently.

Connectivity
The gram 15 has plenty to offer in terms of connectivity, starting off with full-size HDMI, a USB 2.0 socket and two USB 3.0 ports. It also has USB-C, which is both reversible and offers high-speed data transfer, though thankfully isn't used to charge the device.

The Type-C port is also used to gain Ethernet connectivity as an RJ45 adaptor is included in the box. To round things off
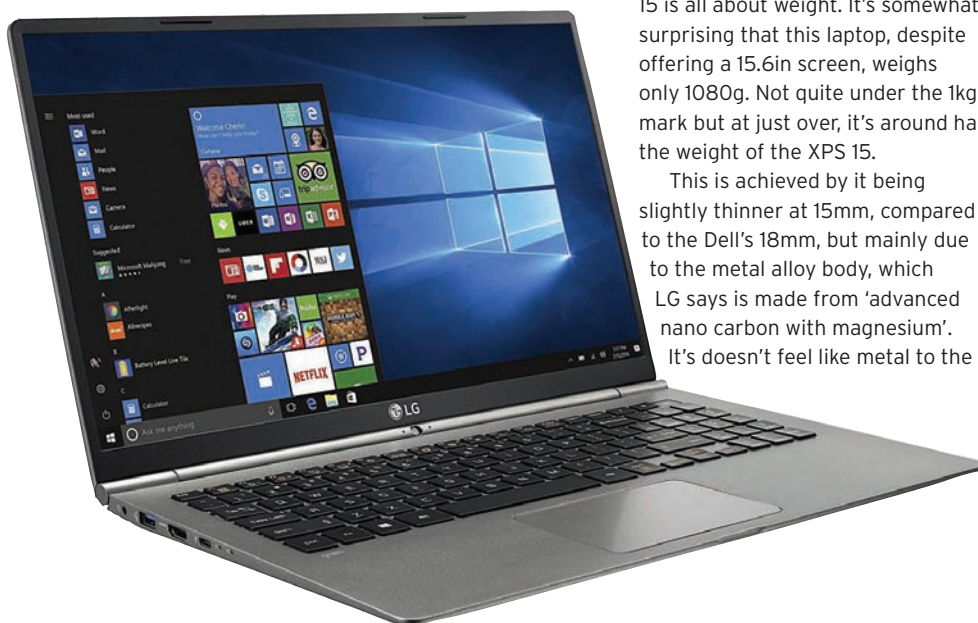
there's a microSD card slot, 3.5mm headphone port with DTS Headphone X processing and a Kensington Security slot.

Keyboard and trackpad

Most 15in laptops squeeze in a numberpad onto the side of the keyboard and the gram 15 is no exception. While this will be handy for some, it creates problems elsewhere: the main issue being that it shifts the main keyboard to the left and typing off-centre isn't particularly comfortable. It also means some frequently-used keys, such as backspace and Enter, are smaller than they perhaps would be otherwise.

The keyboard is backlit, which we'd expect at this price. There are two levels of brightness to choose from, though this doesn't make up for its other shortcomings. The keyboard, for example, took some time to learn in order to touch type due to the layout. Travel and responsiveness is average and nothing to write home about.

As for the trackpad, it's a decent size and responsive. We found it easy to use with Windows 10 gestures as well as in general use. It's not especially quiet for press clicks though, and requires a little bit of force towards the top.

Display

When it comes to the screen we've already mentioned that it's full-size 15.6in, which is impressive considering the overall size of the device. It's a pretty standard Full HD resolution (1920x1080) and uses IPS technology.

You might struggle with reflections at times, but that's an issue with most laptops and the gram 15 has a crisp and colourful display. However, the brightness goes to 257cd/m^2, which is fine for indoor use but not so great outside or in bright conditions.

The Core i7 gram 15 also offers touchscreen technology and although we didn't find ourselves using it much, it may prove a boon for some. That said, the screen wobbles when using touch input.

Performance

As we touched upon earlier, the main reason for this year's edition of the LG gram 15 is an update to the latest seventh-generation of Intel processors. So the laptop either has a Kaby Lake Core i5-7200U with a base clock of 2.5GHz or a Core i7-7500U, which is a little faster at 2.7GHz. Both are dual-core chips with four threads.

The former is paired with 8GB of RAM and a 256GB SSD, while the Core i7 model that we tested comes with 16GB and a 512GB SSD.

In terms of benchmarks, the LG scored a middling 2148 in PCMark 8 and due to the chip being dual-core, scores of 5308 and 4880 in Geekbench 3 and 4 respectively (multi-core test).

That doesn't look great compared to the Dell, which recorded scores of 2810 and 14,049 in PCMark 8 and Geekbench 4 respectively, but this is because the HQ CPU in LG's rival is quad-core. It's worth keeping in mind that the 7500U processor used here is designed for lighter tasks and built for efficiency leading to better battery life.

There's no dedicated graphics card, so you'll be relying on the integrated Intel HD Graphics 620 instead. A score of 1760 in the 3DMark Sky Diver benchmark isn't very good, but this laptop isn't designed to run games.

Battery life

You'd hope that a laptop designed to be extremely portable would offer great battery life, too. However, with LG keeping weight to a minimum, it could have added a tiny battery. Thankfully, that's not the case.

It might not be as big as some of its rivals, but LG has managed to put a 60Wh battery inside the gram 15. This is a little larger than the XPS 15. LG claims it offers up to 12- and -half

hours of power. In our benchmark test where we loop a 720p video at a screen brightness of 120cd/m^2 (60 percent in this case), it lasted an impressive 12 hours exactly.

For comparison, the Dell, with a 56Wh battery, lasted six hours and 24 minutes. Opt for the Core i5 model of the gram 15 and LG claims you'll get up to 15 hours.

Verdict

The gram 15 does what it's designed to do extremely well. It handles Windows 10 and undemanding apps with ease and lasts for ages away from the mains. It does all this while packing a 15in screen into a chassis that weighs just over 1kg. That's seriously impressive, but it comes at a price that's hard to stomach. You should check out the Dell XPS 15 which has more impressive specs for a lower price, but it does weigh twice as much. ⊠ **Chris Martin**

Specifications
15.6in (1920x1080, 141ppi)
TN LCD anti-glare; Windows
10 Home 64-bit; 2.8GHz
Intel Core i7-7700HQ
(3.8GHz boost) 4 cores, 8
threads; Nvidia GTX 1050 Ti
GPU with 4GB RAM; 16GB
2400MHz DDR4 RAM;
256GB SSD; 1TB 5400rpm
HDD; 802.11b/g/n/ac single-
band 2x2 MIMO; Bluetooth
4.1; 3x USB 3.0; HDMI;
Kensington Security slot;
SDXC card slot; stereo
speakers; HD webcam;
single mic; 3.5mm headset
jack; UK-tiled keyboard
with numberpad;
two-button trackpad;
74Wh lithium-ion
battery non-removable;
384.9x274.73x25mm; 2650g

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★☆
Performance: ★★★★☆

★★★★☆

LAPTOP

Dell Inspiron 15 7000 Gaming

The Dell Inspiron 15 7000 Gaming is
a mid-price gaming laptop. It doesn't
offer the most powerful graphics
processors around, but does have
enough power to work as your
main PC and play almost any game
at 1080p with the visuals set to
'medium' or 'high'.

It covers all bases too, with
remarkably good battery life a
highlight that alternatives just
don't get close to. There's one
potentially fatal flaw: most versions
of the Dell Inspiron 15 Gaming
come with a poor quality screen.

Price
Dell's entry-level Inspiron 15 7567
Gaming is available for £899. That
gets you an Nvidia GTX 1050 GPU,
a quad-core Intel Core i5 Kaby Lake
processor, a 256GB SSD and 8GB
RAM. (In the US version, you get a
1TB hard drive instead of the SSD.)

For an extra £200 – that's £1,099
– you get the version we're reviewing
here. It has a 1TB hard drive, plus
a 256GB SSD, a Kaby Lake Core i7
chipset and a more powerful GTX
1050 Ti GPU.

Right at the top of the range is
the £1,299 model. It has a 512GB
SSD and a radically more advanced
screen. Not only is this a 4K panel, it
uses better IPS tech, too.

These laptops come with a one-
year collect-and-return warranty
as standard. You can upgrade to a
better 'on-site' warranty for £68 if
you buy from Dell, and extend that
cover to up to four years. This full-
fat cover costs up to £232.

Design
Gaming laptops from Asus, MSI and
Acer often have colourful keyboard
backlights and great big light-up
designs on their lids. They don't
want to hide their gamer chops.

The Inspiron 15 Gaming is more
subdued. The Dell logo on the rear
is red, and the heat outlets on the
front and back edges are red too,
though as you use the machine it
looks exactly like a 'normal' laptop.

You won't need to feel
embarrassed should you take it
out in a library or a Starbucks, but
it has a few more design flourishes
than a dull office-bound machine.

The Dell's entire shell is plastic,
but it uses a few different finishes.
Its hinge is simple grey plastic,

though the lid and inside are soft-
touch black plastic. The lid picks up
fingerprints readily, but looks and
feels nicer than that of a basic 'meat
and potatoes' model. It's no Dell XPS
15, though looks good nonetheless.

Weighing 2.65kg, we wouldn't
advise buying the Inspiron 15
Gaming if you want a laptop to carry
around with you every day. Plus,
at 25mm thick, it will take up a lot
of space in even a large bag. We
wouldn't want to take this on holiday
or out for work trips too often.

Connectivity
Dell seems to have made this for
people who want an alternative
to a desktop, and you see this in
the connections, too. There's an
Ethernet port for direct connection
to a router, as well as three USB 3.0
ports and a full-size SD slot.

Interestingly, Dell has not
included one of the newer USB-C 3.1
sockets, which is a slight surprise.
Most new laptops seem to have one.
Right now you don't miss it, but in

> You won't need to feel embarrassed should you
> take it out to a Starbucks, but it has a few more
> design flourishes than a dull office-bound machine

two years you might be left wishing you had a USB-C.

Keyboard and touchpad

The Inspiron 15 Gaming has a classic 'larger laptop' keyboard layout. There's a numberpad as well as a normal set of keys, and important keys towards the edge, such as Shift, have not been shrunk down.

We recently reviewed Dell's XPS 15 9560, and while it has a slightly better, meatier-feeling keyboard, we'd be more than happy to live with this one. It's crisp, comfortable and has the same sort of light definition you see in an ultrabook keyboard.

It also has a backlight: tap on the F10 function key and it switches between medium and high intensity. There's no very low keyboard backlight level, but if that's all you need maybe you don't need a backlight at all.

The trackpad below is large for a gaming model and has nice click action. However, it's not perfect: it's made of plastic rather than glass, so is a little less smooth, and there's some unwanted 'pre-click' give to the pad. It also depresses a little under the weight of your finger, which is a shame.

Display

The screen is easily the weakest part of this laptop. Its size and resolution are fine: 15.6 inches is a great size for gamers and 1080p is the best resolution unless you're going to pair it with a true top-end GPU.

However, the Inspiron 15 Gaming has a TN (twisted nematic) panel rather than the IPS kind used in the vast majority of higher-end laptops. These TN screens have much poorer viewing angles, suffering from contrast shift when tilted the wrong way, and shifts in the character of the image from even a slight angle.

Gamers will understand why Dell has done this: TN offers much faster response times than IPS, which is what you want for competitive gaming. But there are good and bad TN panels. On the Inspiron, colour and contrast are both poor,

and the colour tone changed pretty dramatically after a session with our calibrating colorimeter. The Inspiron 15 Gaming seems to have quite a blue-green tint out of the box. Calibrated or not, it can only cover 54.6 percent of the sRGB colour standard. This is pretty standard for a TN display, but it's not what we expect from a £1,199 laptop. Colours look washed out as a result.

Contrast of just 281:1 means blacks are not particularly deep, another reason for the washed-out, faded appearance. Next to the Dell XPS 15 9560, it looks bad.

From a purely practical perspective it fares better, though. An anti-glare surface minimises the effect of reflections and maximum brightness of 300cd/m^2 is enough for use outdoors.

We'd be much more comfortable if this laptop had an IPS screen, though. It's an ugly face for what is otherwise a great system.

Of course, Dell gives you another option. The £1,299 version of the Inspiron 15 Gaming has a much better 4K IPS LCD screen. We've not tested it, but would be surprised if it isn't radically better, having seen 4K IPS panels on the firm's other laptops recently.

Performance

The Dell's performance suffers from no similar issues. All of the available specifications have quad-core Intel Core processors, and the one we're testing here is a very high-end Intel Core i7-7700HQ.

This is a 'do anything' kind of chipset, capable of handling video editing, music production and intense photo editing, as long as you have enough RAM to match. Our 16GB model will sail through more complex tasks like that.

Our review unit has a basic 1TB 5400rpm hard drive and a faster 256GB SSD, onto which the OS is installed. It's fast and responsive, although oddly enough we saw a greater performance difference than expected compared to Dell's XPS 15, which uses the same CPU.

The Inspiron 15 Gaming beat the XPS 15 in PCMark 8, with a very good score of 3105 (to the XPS's 2810), but performed worse in Geekbench 4. It scored a still-great 12050, around 2000 points less than the XPS.

This seems a bit odd when it's meant to be a CPU test, but the Inspiron does also have a much slower SSD. Its read speeds are around 550MB/s rather than 3000MB/s-plus, write speeds 265MB/s rather than 1700MB/s.

Buy one of the two more expensive versions of the Dell Inspiron 15 Gaming and it'll best the XPS 15 for gaming, though. Our review model and the top-end 4K

It uses a 'do anything' kind of processor, capable of handling video editing and music production, as long as you have enough RAM to match

4K one both have Nvidia GeForce GTX 1050 Ti cards rather than the standard GTX 1050. This is a faster version of Nvidia's lower-mid range card, and is capable of running most games very well at 1080p.

On the 1050 Ti version we were sent for review, Thief ran at an average of 51.4fps at max settings, 1080p resolution, which is around 9fps

more than the Dell XPS 15 manages. At 720p, minimum settings the frame rate rockets to 70fps.

Alien: Isolation ran at 179fps at 720p low settings, and 60fps at 1080p high settings. For now at least you can play just about anything you like, including processor-intensive titles. Nvidia's latest cards are very capable.

Typical of a gaming laptop, the Dell gets reasonably noisy under load, but the fans are not whiny or high-pitched and the well-designed air flow stop the parts you touch from getting too hot.

Battery life

Laptops this powerful do not tend to last very long off a charge, even when using a battery saver mode. Around 4.5 hours of light use is to be expected, but the Inspiron 15 Gaming's stamina is miles ahead of this slightly depressing standard. Thanks

to Dell's clever power management, this laptop lasts staggeringly long for a quad-core Intel CPU machine. Playing a 720p video on loop with the screen brightness at $120cd/m^2$, it lasted eight hours and 50 minutes.

It also has reasonable speakers, with better-than-average bass thanks to a 'subwoofer' driver. Unlike some gaming machines, clarity isn't thrown away as a result, and the tone is natural-sounding enough. We'd still choose to plug in some headphones for gaming, though.

Verdict

The Dell Inspiron 15 7000 Gaming gets just about everything right apart from its screen. The design is fine, its performance admirable and its battery life a jaw-dropper. This makes its low screen quality all the more annoying, although at least Dell lets you upgrade this if you can afford £1,299 rather than £899. It's something to consider carefully if £899 is your upper limit, though, as the poor colour and contrast really does not do games justice.
⊠ **Andrew Williams**

£1,799 inc VAT

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Specifications

Case Form Factor Mid-Tower; Windows 10 Home Edition; Intel Core i7-7700 Quad-Core Processor, Liquid Cooled CPU; GPU Nvidia GeForce GTX 1080, Liquid Cooled GPU; 16GB 2400MHz DDR4 DRAM; Storage 960GB SSD; Z270 Mini-ITX motherboard; Gigabit Ethernet; 802.11ac; 400W SFX 80 Plus Gold power supply; 1x USB 3.1 Type-C; 3x USB 3.1 Type-A; 2x USB 2.0 Type A; PS/2 Port; 1x HDMI 2.0; 2x DisplayPort; S/PDIF; 380x200x176mm; 7.2kg; two-year warranty

GAMING PC

Corsair One

PC ADVISOR
RECOMMENDED

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★½
Performance: ★★★★½

★★★★½

As Corsair's first-ever PC, the One is impressive as hell. This tiny machine (which starts at £1,799) is fast, beautifully built, and perhaps more importantly – quiet, too. That's no small feat for a PC that measures just 380x200x176mm.

According to Corsair, a professional lab measured the One's acoustics at idle: 20dB. That's equivalent to someone whispering three feet from you. Quiet at idle is one thing. Quiet when the CPU and GPU are at full throttle is quite another. The One excels on that front, too. It's far from silent (we've certainly heard quieter – albeit much larger – machines under load), but we mostly agree with Corsair's assessment that it would be 'unnoticeable' under normal gaming conditions.

That quiet is the result of the One's design and the liquid cooling of both the CPU and GPU. Most small-form-factor rigs out today using the familiar micro-tower mould liquid cool the CPU but leave the GPU to air cooling. Despite having a larger footprint than the One, those

boxes just don't have the room to liquid-cool both components.

Corsair custom-designed the One's aluminium chassis to hold two low-profile 240mm radiators, one mounted to each interior side of the case. One cools the GeForce GTX 1080 (or 1070 in the lower-end model), while the other keeps the CPU cool. To keep the One's profile small Corsair has foregone fans on those radiators. Instead, a single low-rpm, 140mm magnetic levitation fan mounted up top sucks air from the system. With the radiators mounted flush with the sides, cooler outside air is sucked through the intakes then through the radiator. Call it a semi-passive liquid-cooling system.

Of course, one fan isn't enough to keep the entire system chilled. A second fan mounted on the desktop GTX 1080 cools the card's RAM and voltage regulation modules. Overall it's quite clever, but not without a cost (which we'll get to later).

For ports, you get one USB Type-C 10Gb/s, three USB Type-A 5Gb/s, and two plain USB Type-A 480Mb/s, along with two DisplayPort 1.4, gigabyte ethernet, and a legacy PS/2 port. VR fans will appreciate the front-mounted HDMI 2.0 port. Wireless is 802.11ac. Finally, there's a stack of the standard analogue audio connectors and a SPDIF port.

More important than the ports are the components inside. Corsair is offering three tiers at launch, with the £1,799 base-level One featuring a Core i7 7700, GTX 1070, 240GB SATA SSD, and 1TB hard drive. Step up to the £2,199 One Pro and you get an unlocked Core i7-7700K, a GTX 1080 and a 480GB SSD plus 2TB hard drive.

All three versions use a Z270 MiniITX motherboard stuffed with 16GB of Corsair DDR4/2400 RAM, a 400W SFX 80 Plus Gold PSU and Windows 10 Home. The operating system is what makes this Corsair's 'first PC' rather than just a box

Corsair custom-designed the One's aluminium chassis to hold two low-profile 240mm radiators, one mounted to each interior side of the case

3DMark FireStrike Extreme Overall

Corsair One (Core i7-7700K / GTX 1080) — 9,819
Origin PC (Core i7-5960X / Titan XM) — 9,619
Gigabyte PC (Core i7-6700K / GTX 1070) — 8,313
Cerise (Core i7-6700K / GTX 1070) — 7,981

Longer bars indicate higher performance
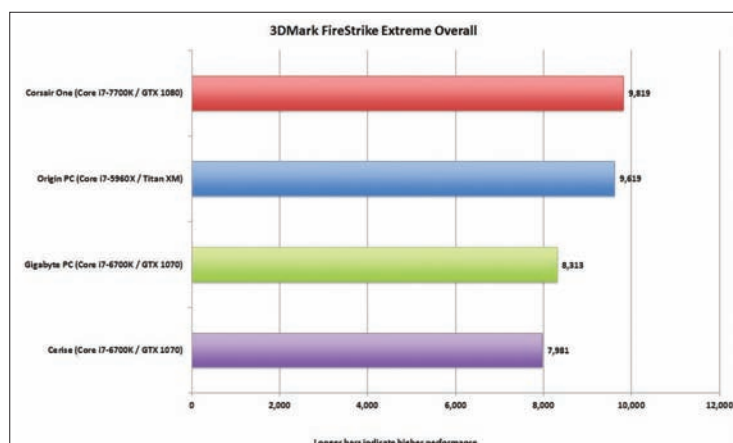
3DMark FireStrike Extreme gives the edge to the Corsair One

Tomb Raider Ultimate 25x16 (fps)

Corsair One (Core i7-7700K / GTX 1080) — 112.6
Origin PC (Core i7-5960X / Titan XM) — 103.4
Gigabyte PC (Core i7-6700K / GTX 1070) — 91.6
Cerise (Core i7-6700K / GTX 1070) — 88.3

Longer bars indicate higher performance
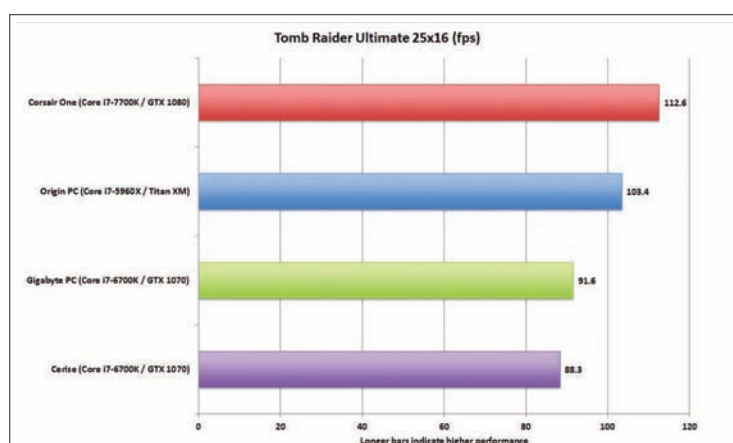
The hardware inside the Corsair One schools older as well as cheaper components

of parts. Many vendors sell bare-bones systems with everything but the operating system, because the minute they install the OS, they're on the hook for all hardware- and software-related issues. Got malware? Problem with the internet? Clouds outside not moving fast enough? Call the PC maker.

So while you might not see it as a big deal that a PC comes complete with OS, know that it's a big deal for a company that got its start making just one PC component.

Most of the One's parts are top-notch, but if we were to nitpick, our first target would be the SSD, a Corsair Force in old-fashioned 2.5in SATA flavour. Sure, it's plenty fast, but with M.2 PCIe NVMe drives offering three to even four times the performance, it's hard to settle for SATA. Note, however, there's room for two 2.5in drives and an M.2 drive inside the One. A 400W PSU seems a bit small and potentially limiting for future

upgrades, but to be fair, you can't really drop a ton of hardware into the One's frame.

Performance

None of these details matter if the One can't keep up with similar desktops, so we put it through our standard system tests. The results were quite good for a machine so small and quiet.

3DMark

First up is Futuremark's 3DMark FireStrike Extreme test. It's a synthetic test (meaning it's not an actual production game engine), but it's still useful for measuring a PC's 3D gaming capability. It's also generally considered to be neutral ground, free from vendor politics. The overall score reflects the performance of both the CPU and the GPU, but is more weighted toward the latter. You can see the One comes in slightly faster than the 8-core Origin PC Chronos equipped

with a Maxwell-era GeForce Titan X. Mind you, we had issues with the Chronos, which ran rather loud.

Tomb Raider

Moving on to an actual game, we ran the older, but still fun, Tomb Raider on the Ultimate setting at 2560x1600 resolution. Again, the One places in front thanks mostly to its higher-clocked seventh-generation Kaby Lake CPU and its Pascal GeForce card.

CineBench R15

Moving on to pure CPU performance, we use Maxon's CineBench R15 to measure a system's ability to render a 3D scene. This particular test loves multicore CPUs, and systems with more cores generally win.

Although no slouch by any means, the One gets left behind by the eight-core Core i7-5960X in the Chronos. It's worth noting, however, that the eight-core chip in the Chronos cost a cool thousand pounds in its day, almost three times the cost of an Intel quad-core chip. Still, the upshot from this test is that if you need a machine for heavy-duty 3D-rendering work, consider an octo-core. The good news? Maybe one day we'll see a Ryzen-based One, too.

Handbrake encoding

Rendering 3D frames isn't something the typical person does, but for a broader look at CPU performance, here's how the One would handle a more common video encode. Up against the Core i7-6700K chips in the Gigabyte PC and the Cerise, the One is fastest, but not enough to matter to most users. Sadly, that's the world of incremental upgrades we live in today with Intel's quad-core CPUs.

Corsair uses dongles to route the GPU's outputs to the back of the system

The Corsair One's liquid-cooled Kaby Lake CPU is fast, but it's still just a quad-core that pales next to an 8-core chip

And yes, we again see the Origin PC take all comers by a healthy margin thanks to its eight cores. It's enough to make us wish there was an affordable eight-core CPU alternative.

Thermals

To sum up the One's performance, it has no problems hanging with PCs similar (or even larger) in size. There are certainly faster machines in existence, but nothing this small and certainly nothing this quiet.

Still, you have to wonder if the One's semi-passive liquid-cooling can really withstand a heavy thermal load. To find out, we ran our unit through 3DMark's stress test for two hours and saw no signs of GPU or CPU throttling in that time.

The upgrade path

Okay, so the Corsair One is small, quiet, and fast. What more could you want? Well, how about easy

In our video encoding test, the quad-core Kaby Lake and Skylake machines can't hang with the older Haswell-E

upgrades? That's where the price of miniaturisation and a custom design whack you on the knuckles. First, getting into the One isn't a snap, but it's certainly not impossible. You first push a button, then remove the cast-aluminium top, then remove

four screws to release the sides bearing the radiators. From there, you can 'easily' access the RAM, CPU, and the SATA drive if you can dig it out from under the cables. As we mentioned before, the One can hold an M.2 SSD and two 2.5in
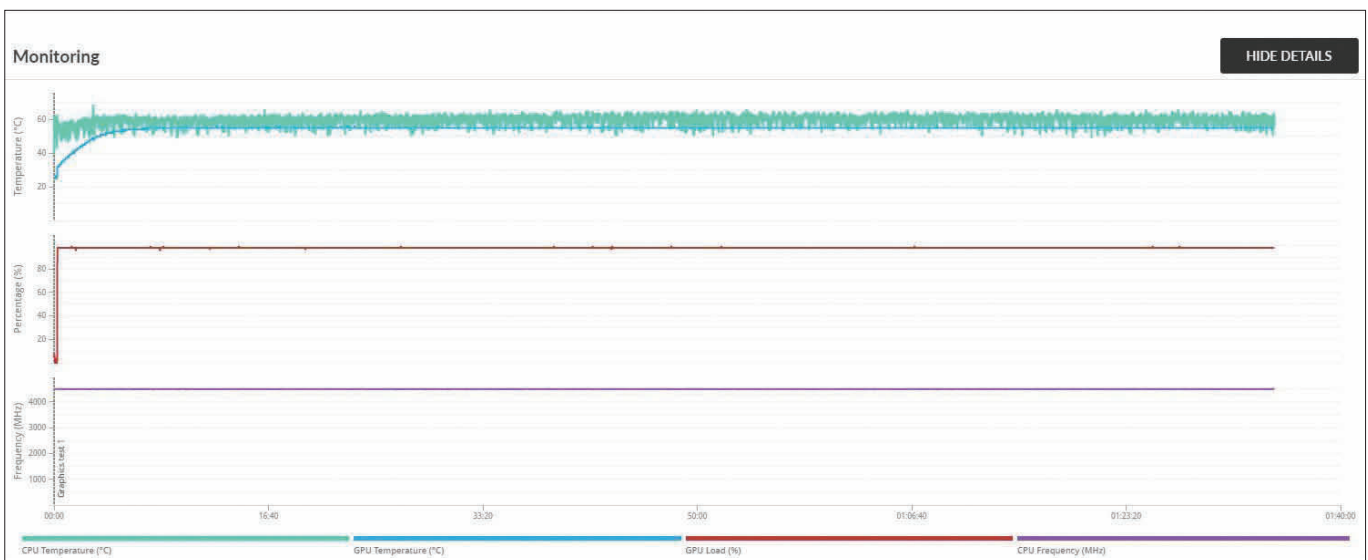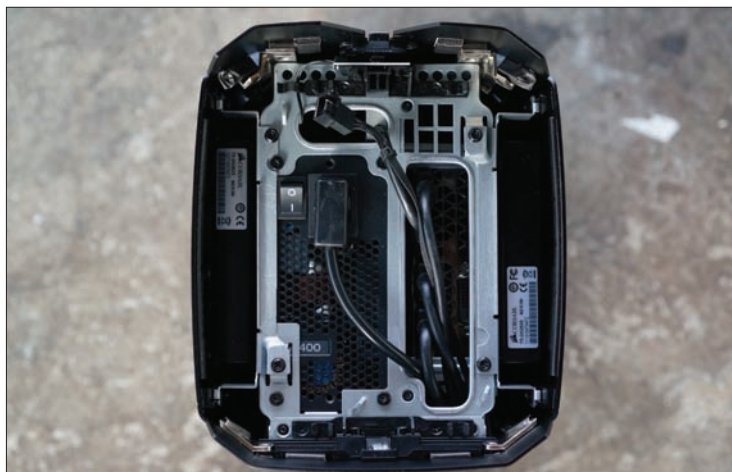
drives; we suspect the M.2 may be mounted behind the motherboard making access major surgery. Swapping the GPU will require a compatible liquid cooler for the upgrade, not to mention time spent extracting the part.

To be fair, this has always been the price of miniaturisation. In fact, we're actually surprised the One is as upgradable as it is, given its size and acoustics. All of the components, as you can see, are industry standard. There's no weird mobile GPU or strange custom motherboard in there. It won't be easy, but upgrading is possible.

Caveat emptor

Here's the catch: Corsair says the act of opening up the One to, say, add RAM or a larger SSD voids the warranty. Period. Want it upgraded? An authorised service centre can do it for you.

Why would Corsair do this? Small computers can be tricky to work on. The firm is likely afraid that a clumsy consumer will try to open it up, destroy things, and then scream for a warranty replacement. That's a valid concern, but we should point out that Dell, HP, and even Apple allow you to add RAM or storage without voiding the warranty

(provided you don't break things). Granted, established PC OEMs have hundreds of different models and huge support mechanisms. First-time PC-maker Corsair has a considerably smaller operation.

To get the most out of your two-year warranty, you basically have to treat the One as a sealed box. And for many that won't be a deal breaker – this amount of power will easily last two years. Corsair also says users can overclock without breaking the warranty.

Verdict

For a first go at the rodeo, Corsair's One PC gets most things right. That's quite an accomplishment when you think about all the moving parts there are to a custom design, much less a complete liquid-cooled PC. Corsair just needs to loosen up its warranty policy to make the One truly superb. ⊠ **Gordon Mah Ung**

£689 inc VAT

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Specifications

5.8in (2960x1440, 570ppi) Quad HD display; Android 7.0 Nougat; dual curved edge display; Exynos 8895 octa-core processor; 4GB RAM; 64GB internal storage; microSD card slot (up to 256GB); 12Mp rear-facing camera with OI; 8Mp front camera; pressure sensitive home button; fingerprint scanner; heart-rate monitor; 11ac dual-band Wi-Fi; Bluetooth 5.0 with aptX; GPS; NFC; 4G LTE Cat 16; headphone jack; USB-C; 3000mAh non-removable battery; wireless charging; IP68 dust and waterproof rating; 68x149x8mm; 155g

Build: ★★★★½
Features: ★★★★☆
Value: ★★★★☆
Performance: ★★★★½

★★★★½

SMARTPHONE

Samsung Galaxy S8

We're huge fans of the Galaxy S7, so couldn't wait to see if Samsung would produce a better phone with the S8. We weren't disappointed.

Price

The Galaxy S8 isn't as expensive as some feared, costing £689, with the S8+ costing an extra £90. That's still pretty pricey though, and a chunk more expensive than the Galaxy S7 which launched at £569.

Design

If the Galaxy S7 was stunning in design, then we're not exactly sure how to describe the S8 apart from that it's on another level. It makes its predecessor, and other phones, look rather dated.

Samsung has brought its edge screen technology to both phones this year, so you don't need to buy the larger S8+ to get the full experience. This not only looks great but has a big advantage when it comes to keeping the size of the phone from getting out of control.

The S8 is pretty much the same width, thickness and weight compared to its predecessor. It's just a few millimetres taller, but jumps from 5.1- to 5.8in when it comes to screen size. So what would typically be an unwieldy device feels barely any different in the hand.

It's an impressive piece of craftsmanship, largely down to significantly reducing the bezels at the top and bottom. A screen-to-body ratio of over 83 percent is impressive stuff.

The physical home button and accompanying capacitive keys have been removed to achieve this. Now you have on-screen navigation and a pressure sensitive home button built into the display – we'll talk about this later.

The fingerprint scanner is now on the rear, though awkwardly next to the camera rather than below it. Right-handed users are likely to smudge the camera when using it. This is our main bugbear in terms of the design and it should really be below the camera, despite creating an unsymmetrical look.

A lot of users will be pleased to see that the headphone jack has been retained on the bottom. Like its predecessor, the Galaxy S8 is made from a lot of glass, so is a little slippery. Because of this Samsung has used Gorilla Glass 5 on the rear for extra protection. You'll probably want to get a case to protect this expensive slab of metal and glass though, which is a shame considering the outstanding design.

As you'd expect, the Galaxy S8 is fully dust- and waterproof, so has an IP68 rating. That extra button you see on the left side of the phone is to quickly launch Bixby, Samsung's artificial intelligence assistance.

The S8 comes in five colours, though only three will be available at launch: Midnight Black, Orchid Grey and Arctic Silver (the latter with arrive at a later date). Samsung may well bring the blue and gold options at the later date, but we'll have to wait and see.

Features

Compared to the Galaxy S7, the new S8 isn't dramatically different when it comes to specifications and hardware on offer. That's partly because the S7 ticked a lot of boxes, though there are new components, with the screen being the most obvious change.

Infinity Display

As mentioned in the design section, Samsung has impressively increased the size of the display from 5.1- to 5.8in. This is despite the phone being only slightly taller in shape. If that's not big enough, the Galaxy S8+ has a whopping 6.2in screen.

Like the LG G6 (page 48), the Galaxy S8's display's rounded corners look great and match the curvature of the phone's metal frame. Samsung has also opted for a similar aspect ratio of 18.5:9 meaning the screen is very tall (or wide in landscape). Samsung calls it the 'Infinity Display'.

You can fit more on the screen, of course, and the aspect ratio

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If the Galaxy S7 was stunning in design, then we're not exactly sure how to describe the S8 apart from that it's on another level

Geekbench 4

Device	Score
Galaxy S8	6466
Galaxy S7	5370
Huawei P10 Plus	6108
OnePlus 3T	4257
Google Pixel	4116
LG G6	4251
iPhone 7	5669

GFXBench Manhattan

Device	Score
Galaxy S8	54fps
Galaxy S7	27fps
Huawei P10 Plus	20fps
OnePlus 3T	47fps
Google Pixel	47fps
LG G6	24fps
iPhone 7	59.1fps
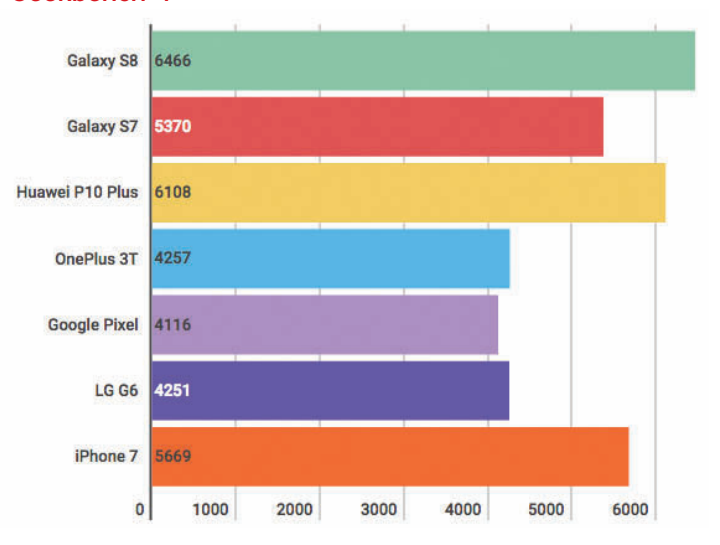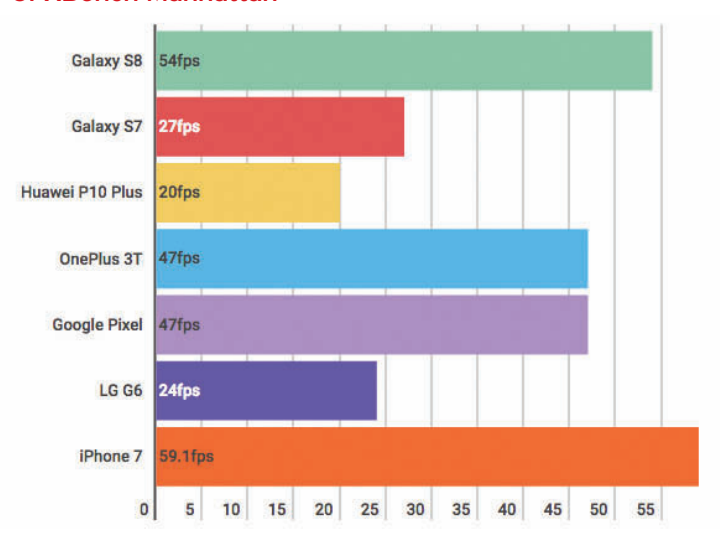
suits content such as videos much better, so you can, depending on the source content, watch videos without annoying black bars.

The phone sticks to Samsung's preferred SuperAMOLED display technology ensuring great contrast and colours. The screen resolution is WQHD+, 2960x1440 in this case because the screen is so tall. A pixel density of 570ppi is enough for anyone. It's worth noting it defaults to Full HD+ (2220x1080), but you can change it in the settings if you wish. The lower resolution improves graphics performance and also aids battery life without a noticeable drop in quality. If you want, you can also drop it down to 1480x720. Specifications aside, the Galaxy S8 also now has the well-known edge screen as standard, so there's no need to buy the edge version any

longer (like the Galaxy S7 edge). The curve is more subtle than previous edge devices though, so you just have the edge panels rather than any other additional functionality.

There are some new features to make the screen easier to use one-handed which we'll cover in the software section, and the display is always-on should you want it to be.

One last thing to mention about the screen is that it has Mobile HDR Premium certification by the UHD alliance. The ability to display HDR content sounds good but you'll only get it with certain titles on Amazon Prime Video. More partners will be announced.

Processor
Once again, the Galaxy S8 has have a different processor for different markets around the world.

Samsung has been a bit vague on the subject but, as we suspected, the UK model has the firm's new Exynos 9 8895 chip rather than the Qualcomm Snapdragon 835 that the two companies collaborated on.

The firm's latest eight-core processor has clock speeds of 2.3- and 1.7GHz (four cores each) and a Mali-G71 MP20 GPU. The firm claims a 10 percent increase in CPU performance and a 20 percent gain on the GPU side. We're very impressed with the performance here with some of the highest benchmark results we've seen. It's the graphics boost that's particularly noteworthy considering the resolution. We tested at default settings and switching to the full amount of pixels didn't drop the frame rates much.

Memory and storage
Not a huge amount has changed in this department. The phone has 4GB of RAM and comes with 64GB of storage as standard. As usual, the phone has expandable storage so you can add up to 256GB via the microSD card slot.

Connectivity
As you'd expect from a flagship Samsung phone, the Galaxy S8 is packed with all the latest connectivity specifications.

To this end, it has dual-band 11ac Wi-Fi, NFC, GPS, Bluetooth 5.0 and LTE Cat 16. It also uses a reversible USB-C port like recent Samsung devices and rivals. The heart-rate monitor also remains, but has been moved to the other side of the camera module.

Fingerprint and Iris scanners
As we touched upon earlier, the fingerprint scanner has moved to the rear in order to fit a much larger screen. We're all for this – LG has been doing it since the G2 – but the placement isn't very ergonomic.

Samsung appears to have prioritised the symmetry of design over functionality here, so most users will be making the camera lens grubby when reaching for the sensor. The scanner is fast when it works, but its placement and size make it frustrating to use, especially with a case on.

The firm says you won't need the fingerprint scanner as much

because of the improved Iris scanner, which debuted on the Note 7. While this works, it's still frustrating to use a lot of the time as you'll need to hold the phone up like you're taking a selfie, hold it the right distance away and require things like good lighting. If you're concerned about security, then the S8 is likely to be a bit annoying, with the best options being a pattern or numerical PIN rather than the more advanced biometrics.

Cameras

There's no change from the fantastic camera inside the Galaxy S7. So the S8 has a 12Mp Dual Pixel with an impressive f/1.7 aperture and other features such as optical image stabilisation (OIS) and 4K recording.

The camera also offers 'multi-frame image processing' where it takes three shots instead of one and uses the extras to do things like reduce blur and perfect other elements like focus.

It's the new processor that makes this already awesome camera even better. Some shots, unedited, are unbelievable (opposite).

There are loads of different filters and shooting modes to play with including the usual suspects. There's even a new food mode for showing off your restaurant orders or home cooking skills.

We were suitably impressed with the S7's camera and although it's essentially the same tech here, the S8 is one of the best phone cameras on the market.

When it comes to the front camera things are similar with a matching f/1.7 aperture, though the resolution has been bumped from 5- to 8Mp. The wide aperture means you can shoot in much harder conditions than most phones and the results in general are sharper and more detailed than before.

If you're worried about jumping to a much larger screen size Samsung has made tweaks to help you operate the phone with one hand. In the camera app we found it easy to switch between the cameras, modes, filters and even zoom all with different thumb swipes.

Battery life

Samsung hasn't made a fuss about battery life on the Galaxy S8. This may be due to the fact it has the same 3000mAh capacity

GFXBench T-Rex

	fps
Galaxy S8	60fps
Galaxy S7	53fps
Huawei P10 Plus	41fps
OnePlus 3T	60fps
Google Pixel	58fps
LG G6	46fps
iPhone 7	60fps

JetStream

Galaxy S8	54.9
Galaxy S7	61
Huawei P10 Plus	56.6
OnePlus 3T	53.6
Google Pixel	54.9
iPhone 7	160.2
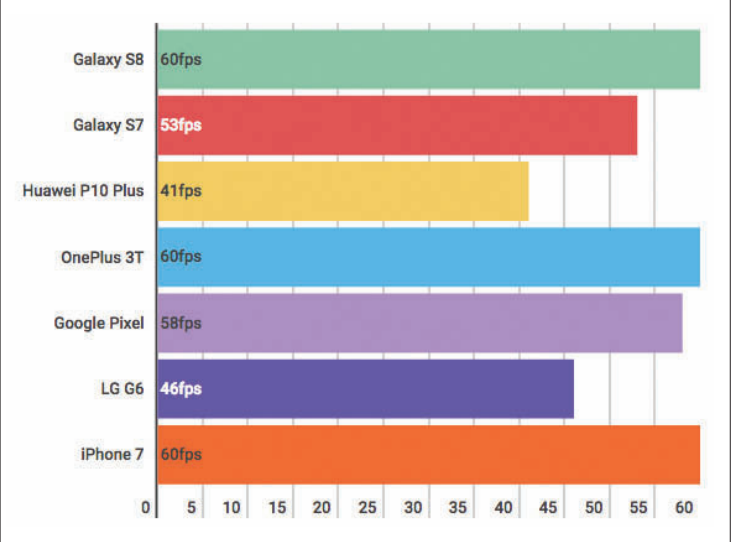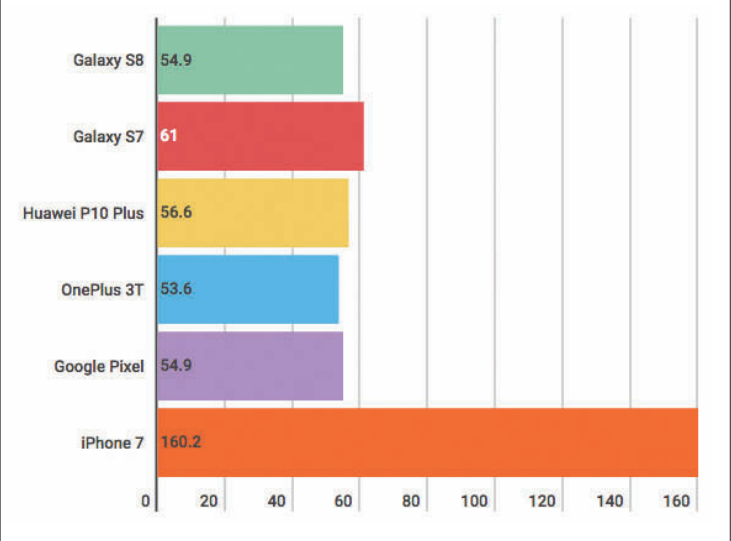
as its predecessor. Nevertheless, it's good to see features such as USB-C, fast charging and wireless charging as standard.

Battery life will always be better when a phone is new and unused but we are, nevertheless, impressed with the S8. During our time with the phone, it lasted almost 48 hours of moderate usage.

Software

Manufacturers don't typically sell phones because of the supplied software, and this is largely the case with the Galaxy S8, though it has some interesting elements.

Android 7.0 Nougat

As you'd expect, the phone comes preloaded with the lasted version of Android (7.0 Nougat) and Samsung hasn't messed about with it too

much. The interface remains clean and easy to use, but still has lots going on behind the scenes.

You get a lot of preinstalled apps, though most are useful including Google's, Microsoft's and Samsung's own. The app draw is now accessed with an upwards swipe, which will take some users a while to get used to. You can swipe up from the end of the menu to return to the home screen.

There's tonnes of things you can customise with the software, including the home screen and app draw grids. It's easy to get lost in the settings menu with the amount of options with things you simply won't know about unless you go and look. An example of this is the fingerprint sensor gestures, which are switched off by default. They allow you to open and close the notification

The Galaxy S8's unedited shots look fantastic

panel by swiping, which is handy with a tall screen like this.

Since the navigation buttons are on-screen you can swap back and recent apps around – handy if you're coming from another phone and not used to Samsung's layout. You can even adjust how sensitive they are to avoid pressing them by mistake.

Snap Window

Moving to a bigger screen, despite the phone not being much bigger, presents a problem. A larger display means it's harder to reach it all with one hand. As mentioned earlier, things such as the camera app have new controls to help you out. A new feature for the S8 is called Snap Window and takes advantage of the tall screen size. It's essentially a new part of Multi Window and allows you to snap a chosen section of an app to the top part of the screen. Below it you can carry on like normal on a still larger chunk of the real estate.

Bixby

Bixby might sound like a new cuddly mascot but it's Samsung's answer to the likes of Siri and Google Assistant. There's even a Bixby button on the side, so you can access the feature quickly, without unlocking the device. Sadly, you can't change what it does. The idea is you can talk to Bixby and it will understand the context of what you're doing.

There's also Bixby vision, which does clever things. If, for example,

you point the phone's camera at a local landmark Bixby will provide information about it, along with places in the area to eat.

It's worth noting that much of the functionality is available via Google Assistant (which is on the phone) and Bixby will be limited to selected Samsung apps to start with. You also won't be able to use the voice element at launch with UK language support arriving at an unknown later date.

Until then, you'll have to make do with Bixby Home – the interface loads if you push the physical button on the side or swipe right from the home screen. Here you'll get, in a very similar way to Google Now, all kinds of information that should be useful such as the weather, news, fitness stats and suggestions.

While this sounds great during our time with the phone we weren't convinced by it, especially with the lack of voice support at launch. Google Now is already a much better alternative and probably always will be.

DeX

We're actually more interested in DeX, a docking station which lets you use the Galaxy S8 as a makeshift PC for £129. You connect the phone via USB-C and the dock as two USB ports, Ethernet, HDMI and a cooling fan.

You can also use it with a wireless keyboard and mouse and once the phone is docked you'll get a custom desktop-style interface

where you can open and resize apps in separate windows like you would on a PC or laptop.

Other new accessories include a new Gear 360 2 camera and a tweaked Gear VR headset bundled with a motion controller.

Verdict

Samsung has taken the best phone around and made it even better with an impressive screen and design. It ticks a shed load of boxes you'd want a flagship to do. It's the best phone of 2017 so far but it is expensive and the biometrics are a let down. We're keen to see what the likes of Apple, HTC and OnePlus can do to challenge. ☒ Chris Martin

The DeX docking station lets you use the S8 as a makeshift PC

Specifications
5.7in (2880x1440, 564ppi) 18:9 Quad HD display; Android Nougat 7.0; Qualcomm Snapdragon 821 processor; Adreno 530 graphics; 4GB RAM; 32/64GB storage (region dependent); 13Mp dual rear cameras, Wide (F2.4, 125 degrees); 13Mp standard OIS 2.0 (F1.8, 71 degrees) LED flash; 5Mp front camera, Wide (F2.2, 100 degrees); 802.11 a/b/g/n/ac Wi-Fi; Bluetooth 5.0; 4G LTE; Nano-SIM (Dual SIM in some regions); GPS; NFC; 3300mAh non-removable battery; Qualcomm Quick Charge 3.0; IP68 water resistant; 148.9x71.9x7.9mm; 163g

Build: ★★★★½
Features: ★★★★½
Value: ★★★★☆
Performance: ★★★★½

★★★★½

SMARTPHONE
LG G6

The G6 comes at a crucial time for LG: it made a loss in 2016 following the disappointing sales of the G5 and V20. The firm's new handset is a bold step in the right direction, though that doesn't always save a company's fortunes. To cut to the chase, LG G6 is an astonishing device that easily holds it own against the best smartphones ever.

Design
So LG has gone big, but it's the screen, not the handset itself, that's grown. The G6 has an 18:9 panel, expanding the display from the traditional confines of 16:9. This leaves it with a 5.7in Quad HD screen. It looks seriously good.

Alongside that wonderful display is a design that conforms, unlike the modular G5 and the leather-clad G4. The G6 takes a leaf out of the iPhone 4's book with a solid aluminium frame and Gorilla Glass on the front and back. It comes in Ice Platinum (pictured), Mystic White and Astro Black, with only the latter being a true fingerprint magnet.

The refined design is simpler and more elegant, with the dual rear cameras and fingerprint sensor that acts as the power/lock button sitting flush with the body. The bottom edge houses the USB-C port (fully waterproof), single speaker and mic. The right edge is smooth and clear save for the SIM tray, while the left edge has the two volume keys. The top edge has that very welcome 3.5mm headphone jack.

Even though the metal and glass frame isn't entirely original, the design is made all the more striking thanks to the rounded corners of the actual display as well. It's a clever detail that doesn't negatively affect use, while accentuating the G6's thin bezels and unusually tall screen.

The black phone sports this look slightly better than the white or platinum handsets, though. The rounded screen actually has a tiny thin black gap between it and the coloured bezels, but it's enough on the white and platinum models to be constantly visible. Though it's there on the black, it's invisible and makes for an even better visual impression.

So, while we prefer the platinum smartphone for looks and how it

hides fingerprints, the black one wins because the rounded screen simply looks better on it.

LG said its goal with the G6 was to make a phone with a huge screen that you could comfortably use with one hand. The problem here is that that is basically impossible, even for those with large hands. Where the company has succeeded though, is by making the G6 perfectly pocket friendly, while packing in a screen that is easy to scroll through and hold with a single paw.

This might sound easy to achieve, but it can be rare to find on phablets such as the G6. The iPhone 7 Plus, for example, is a through and through two-handed device, and the G6 succeeds in fitting a larger screen than that phone into a smaller overall body.

From the precision cut metal rim to the flat back that still packs in dual cameras and a fingerprint sensor, and, of course, the screen, LG has hit a home run with this design. If at first it looks ordinary, in use it really is far from that. No gimmicks, no leather, no risks – just incredible build quality that positively affects daily use.

Features
In the tech press, a new high-end smartphone usually takes a fair (and unfair) battering simply because of the specifications. To us, the G6 actually feels like a marriage of hardware and software that transcends this sort of nitpicking because it works so well as a cohesive whole. The flack the G6 has received for using the Snapdragon 821 is a little unfair given how well it performs. Here we'll break down the features and specifications for you to decide for yourself what you make of LG's decisions.

Processor
One point of contention among the tech community is LG's decision to go with Qualcomm's Snapdragon 821 processor rather than its latest 835, which Samsung has used in the US version of the Galaxy S8 (page 44). The 821 is in its third generation, and LG told us that it therefore has more expertise in how to optimise the user experience (UX) and implied the 835 wouldn't have brought any more noticeable advantages.

The G6 can handle some pretty heavy multitasking. We swiped

Geekbench 4

LG G6	4251
OnePlus 3T	4257
Google Pixel XL	4067
Sony Xperia XZ	3807
iPhone 7	5669

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000

GFXBench Manhattan

LG G6	24fps
OnePlus 3T	47fps
Google Pixel XL	30fps
Sony Xperia XZ	48fps
iPhone 7	60fps

0 5 10 15 20 25 30 35 40 45 50 55 60 65

GFXBench T-Rex

LG G6	46fps
OnePlus 3T	60fps
Google Pixel XL	55fps
Sony Xperia XZ	60fps
iPhone 7	60fps

0 5 10 15 20 25 30 35 40 45 50 55 60 65
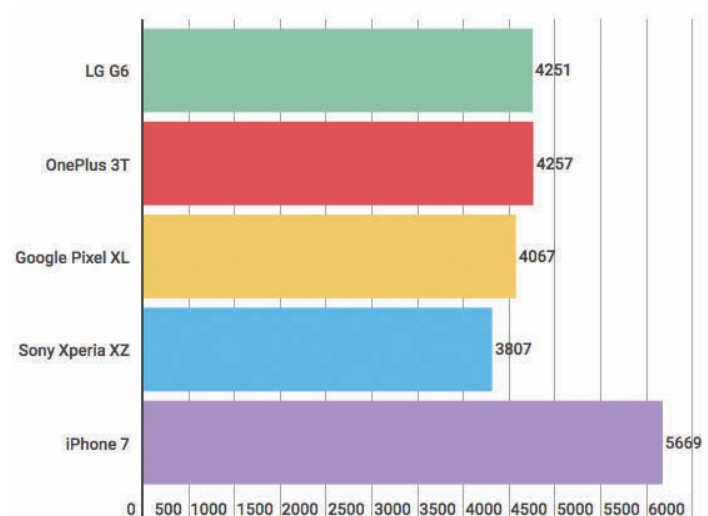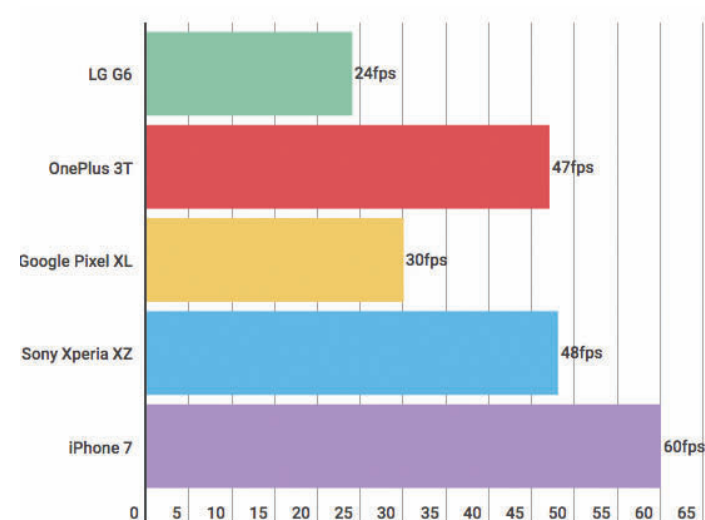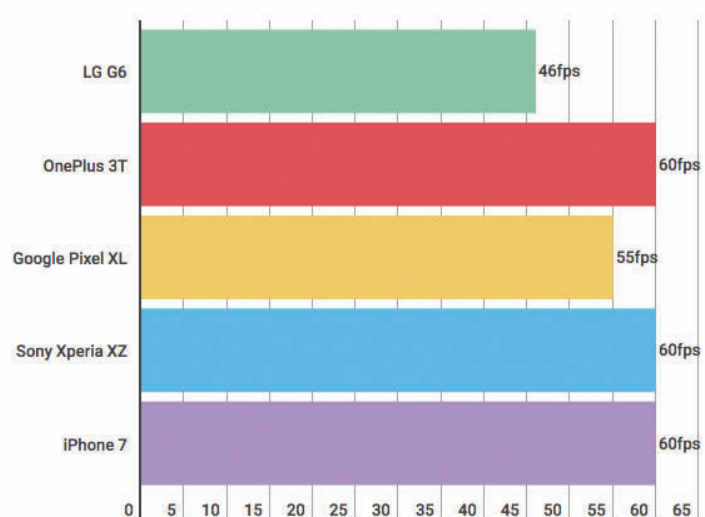
between games, video streams, Spotify, document editing and more and the phone barely broke a sweat. Very occasionally in some apps (Spotify, for example), we noticed a tiny lag on album art when switching songs, but live streaming services often do this even on high-end phones. We can't imagine anyone having complaints about the G6's performance, and our benchmarks (see left) reflect how it holds its own against the best of the best. In fact, it is one of the best.

You'll notice some of the frame rate scores are lower than the G6's market rivals; the OnePlus 3T and Google Pixel have the same 821 processor but have better scores.

We are putting this down to the larger resolution on the G6 and its Full HD display, and the processor needing to push that bit harder to keep up. At no point during gaming, for example, was the frame rate lagging, but if top specs that give maximum possible performance are your thing, you may want to take this into consideration.

Display

The G6 comes with a 5.7in Quad HD screen with a resolution of 2880x1440 and is stunning. The extra pixels on that first figure are to account for the 18:9 aspect ratio, which you will get used to much quicker than you might think.

The latency is very good, with very fast response, but it still is a touch (tiny touch) behind the iPhone 7, but very comparable to any other Android phone we have used. It never affected our use of the device.

Aside from the 564ppi, the extra height of the 18:9 aspect means the whole experience of using the G6 is improved from the G5. If that sounds a bit too vague, it's because you really need to get your hands on it to see what we mean. The extra height just makes sense in the slim form factor, and you really will use it with one hand. This impression is also intrinsically linked with the changes to the software.

The display also retains the always-on functionality from the G5, with a slightly altered set-up lower down on the screen and a new default font. It still displays the time, date and apps that you have notifications for.

The rounded corners really help the screen; they make it feel more

contained, almost as though the panel has been penned in for fear of it becoming to large. This is to positive effect, and we found that everything from home screen swipes to typing long messages was a joy on the larger display. There was a lot of room for error here, but in terms of presentation, LG has nailed it.

Cameras

The LG G5 impressed us with its dual camera set-up that enabled wide-angle shots. The G6 retains this, with two 13Mp rear-facing cameras. The wide-angle lens offers a 125-degree angle and the standard has optical image stabilisation. LG claims it has found an algorithm that lets you zoom between the two cameras smoothly without a software jerk. We found, unfortunately, that this isn't the case: there's still a tiny flicker as the lenses switch over.

These cameras can record up to 60fps at full HD quality, and in ultra HD at 30fps. HDR support is only for still images, not video, but this is usual for smartphones.

We found general image quality to be excellent. The display is a joy to use as a viewfinder given its size and the root files themselves show a superior handling of composition.

The wide-angle lens option is still best on the G6 in comparison to rivals. The user-friendly presentation in Auto mode means you can easily and quickly switch between the two.

The camera is also good at handling macro-style shots, and most casual users won't need to stray into the manual mode, though if you do it's well set up.

Something that's more pushed in LG's marketing is the camera's Square mode that panders towards Instagram friendly shots. It also fits in nicely with the G6's square themed GUI. There are four shooting options in square mode: Snap, Grid, Guide and Match. Here's a quick rundown of what they do.

Snap splits the screen in half and means once you've taken a picture you can preview it straight away, while the second half of the screen remains a viewfinder to take another shot in. Handy if you're trying to get a perfect picture of an important subject (potentially your own face).

Grid is a quick way to create a four-image grid of pictures that is itself

a square. It's the most simple and effective mode.

Guide is where it gets slightly too clever for itself, with the option to pick an image from your gallery to act as a ghosted guide image with which to overlay in the viewfinder and better compose another picture. It ends up overcrowding the screen and is confusing to use.

Match is set up to capture two images like in Grid, but this is to be slightly kooky and combine (LG suggests) candyfloss with a vapour trail to create a trick image. It's very hard to use and even harder to get a decent shot.
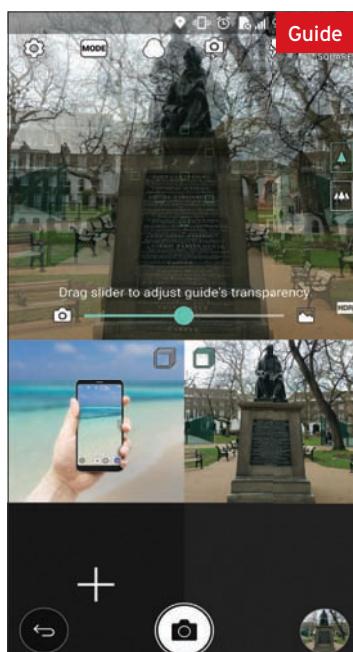
They are fun modes to play around with, but it's a distraction from the very good sensor that takes normal photos very well. LG is trying to please the Instagram generation, and it has most likely succeeded there.

Storage and RAM

The LG G6 comes with 4GB of RAM as standard and 32GB storage. There's also a microSD slot for expansion up to 256GB.

Connectivity and extras

The G6 does have one trick up its sleeve for all regions, though: LG claims the G6 is the first smartphone to support both Dolby

The L6 G6 is a striking phone. Metal and glass shimmer, while the 18:9 screen is brought to life with the improved software and rounded design

Vision and HDR 10. In basic terms, it's the first handset to theoretically support superior audio-visual standards normally associated with high-end televisions.

We say theoretically because while it supports both, streaming services such as Netflix don't actually yet offer playback of this combined quality on mobile devices. Remember when everything was 'HD ready', before HD actually existed? It's like that. Watch this space.

Where it falls down slightly – but thankfully not too much – is in how it adjusts to display content that is by default 16:9 or similar. Netflix, foe example, will display the video in 16.7:9 on the G6. Swiping down from the top of the screen gives you a green icon, tap that and you have the option to view in 16:9 or expand to the full 18:9. If you opt for the latter, it warns you: 'The app's content may not be fully displayed'.

It's a bit fiddly and we found it meant having to return to the Netflix home screen. Plus, in every option, some form of black bar remained on at least one edge to make sure all the content was still visible. It's far from ideal if you want to view apps using the full display.

LG told us that it was working directly with Netflix to sort this out and bring a seamless 18:9 video experience to the G6, but we remain worried that with the plethora of services and games out there, the G6 might be doomed to a life of black bar playback.

Battery life
The G6 has a 3300mAh non-removable battery. This might bug LG fans of the G4 and G5 whose batteries you could remove, but in reality this is the correct decision. The battery is big enough to last a full day and the bundled fast charger continues Android devices' pleasing trend of above-average battery life and very fast top up times.

Our review unit was a pre-production model, so perhaps the slight erratic nature of the battery life can be put down to that. It was the only area of use that we

suspected might be improved with the final retail version. We were never left without charge, but some days the G6 would be on 75 percent by bedtime with reasonably heavy use (which is outstanding), while other days it would reach that with light use by mid-morning.

Software
The G6 ships with Android Nougat 7.0, but then again it would be a crime if it didn't. LG's overlay has a certain playfulness in the pastel colours, square design focus and rounded edges influenced by the screen. It is, however, well refined, with everything from app animations to menus flowing well.

It takes a bit of getting used to if you're coming from Samsung's TouchWiz or pure stock Android, but after a time it's just as fun and practical to use as them.

The G6's software has been substantially overhauled from the G5's in order to play nice with the taller 18:9 screen. LG's own apps, such as messaging, weather and calendar, have been redesigned to better manage white space and information displayed since there's more room to play with.

Apps have more space to work with, so LG has worked very hard to bring the user a more aesthetically pleasing experience, working on attractive, modernised graphics in the main apps.

The camera software, too, has been redone, with some excellent use of the extra screen space. We love that when taking photos landscape, you get a camera roll of the last few photos taken, rather than the smartphone norm of one tiny thumbnail of the one most recent photo.

We also welcome LG's decision to choose whether or not to display apps iOS style on the home screen or store them in an app tray. We don't mind it on iOS, but given the choice on Android, we'll pick the app tray every time.

Multitasking is also good on the G6. As with all Android phones that allow it, you can't use it with every

app, but it's handy if you want to run two apps simultaneously. It works best though without a keyboard on-screen. As soon as you need it, even the 18:9 aspect can't cope with the room needed, and multi-window becomes useless. It's still a feature that we don't really use, even though some continue to push it.

Verdict
The LG G6 is a striking phone. Metal and glass shimmer, while the huge 18:9 screen is brought to life with the improved software and its rounded corner design. It is a more refined handset than both the G4 and G5, and should appeal to a broader audience. There's a lot to cover with the G6, and it's a complicated phone to assess. The differences in hardware and the tweaks in software mean it's a phone that reveals itself to you more slowly than the immediacy of, say, the Galaxy S8. The design looks uniform at first until you realise how well it all comes together. LG has managed to build a mature phone with next to no bezels and some unique tweaks to software, leaving it feeling fresher and more creative than any Android phone we've seen for a while ☒ Henry Burrell

Specifications
5in (1080x920, 441ppi) touchscreen; Android Nougat 7.0; 1.4GHz Qualcomm Snapdragon 430 octa-core processor; Adreno 505 graphics; 2- or 3GB RAM; 16GB storage; 13Mp main camera, LED flash, support for 1080p video at 30fps; 5Mp front camera; 802.11 a/b/g/n Wi-Fi (2.4 and 5GHz); Bluetooth 4.2; 4G LTE; Nano-SIM; 2800mAh removable battery; Micro-USB rapid charging; microSD support up to 128GB; water-repellent nano-coating; 144.3x73x9.5mm; 144.5g

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★⯪
Performance: ★★★☆☆

★★★★☆

SMARTPHONE

Moto G5

'Premium for All' is Lenovo's new motto for its G5 phones, the Moto G5 and G5 Plus, which aim to offer the build quality and feel of a flagship device at decidedly non-flagship prices. That's especially true of the G5, which offers a metal body, rapid charging, and fingerprint sensor controls – all at a sub-£200 price.

Design

Design is where the G5 has seen the biggest overhaul from its predecessor. The phone features an aluminium body – instead of the G4's plastic – which means it immediately feels like a more expensive phone than it is. The 5in display stretches most of the way to the sides of the body, though there's still plenty of bezel at the top and bottom – it's not quite Galaxy S8 (page 44) premium.

The rear of the phone is dominated by the large camera aperture that sits above a brushed metal Motorola 'M'. At 144.5g, it's a comfortable weight and has that reassuring heft of any metal-bodied device, while it measures 144.3x73x9.5mm, which is small enough to use in one hand. It's available in Lunar Grey, Sapphire Blue or Fine Gold – our review unit was the grey model (pictured), which is attractively understated.

The G5 doesn't offer the sort of striking design that's likely to turn heads – at least not until you tell someone how little you paid for it. It's mostly straightforward, unassuming stuff, but it's the feel of the phone and its build quality, that really sells it. This is a handset that feels and looks well-made – 'cheap' never once sprang to mind. It's simple, it's elegant and there aren't many better-looking phones that will cost you this little.

Features

Offering that sort of design and build quality at less than £200 comes at a price, of course, and the Moto G5's internal specifications are where it lives down to its price.

It's powered by a Snapdragon 430 with a 1.4GHz eight-core CPU and 450MHz Adreno 505 GPU. Our review unit came with 3GB RAM, though you can also get it with 2GB. With only a £10 price difference,

we'd find it hard not to recommend opting for the higher-spec model.

To be blunt, the benchmark results aren't great (see opposite). We were surprised to see slightly worse scores than from 2016's G4, likely because it runs the more recent – but less powerful – Snapdragon 430, compared to the G4's Snapdragon 617. Even a better GPU and more RAM weren't enough to make up for the CPU gap.

Even so, in day-to-day use the G5 never feels sluggish or slow, and it should be more than enough for average usage, including streaming video and light gaming. The G5 never feels like it's underperforming, despite the benchmark results.

The 5in display is full 1080p and 441ppi, with crisp, bright colours, though it has no Gorilla Glass protection. Below that you'll find the fingerprint sensor, which doubles up as a replacement for Android's on-screen buttons, through some nifty swipe controls.

The Moto G5 comes with a disappointingly small 16GB of on-board storage, but there's support for microSD cards up to 128GB.

The rear camera is 13Mp with LED flash and phase detection autofocus, while the front camera is 5Mp. Taking photos with the autofocus was almost instantaneous, and for the most part we were able to capture crisp, clear photos even in challenging lighting.

There's a 2800mAh battery, which should provide a full day's use pretty comfortably. The most we managed to wear it down to was 20 percent after 16 hours of usage, including some heavy camera and internet use – you can trust the G5

to last the day, but you will want to charge it each night.

It comes packaged with a 10W Micro-USB rapid charger, which is able to provide a few hours of battery life after just 15 minutes or so of charging – as long as the battery is low to start with. It also supports TurboPower charging, which can offer six hours of battery in the same time, though you'll have to buy the charger separately.

There's also 2.4- and 5GHz Wi-Fi, GPS, Bluetooth 4.2 and a water-repellent coating. One big omission is NFC, so you won't be able to use Android Pay or its equivalents. Don't worry though – you do get a 3.5mm headphone jack.

Software

The G5 comes loaded with Android 7.0 Nougat, and runs a version that's close to stock, with a few 'Moto experiences' added on (more on those in a moment). What this means is that if you're looking for something not far from the pure Android experience, but don't want to splash out on the Google Pixel, the Moto G5 could be a good option.

It's also one of the first phones included in the search giant's new expansion of its Google Assistant services, previously limited to only a handful of handsets, though it wasn't on the G5 at launch. Eventually, you can probably expect the new AI assistant to be ubiquitous across Android, but for now this will be one of the cheapest ways to get your hands on it.

The big difference from stock Android is the inclusion of the gesture-based 'Moto Actions', some

Geekbench 4

Phone	Score
Moto G5	2322
Moto G5 Plus	4225
Galaxy A3	3297
Lenovo P2	2890
Moto G4	3174

GFXBench Manhattan

Phone	Score
Moto G5	7fps
Moto G5 Plus	10fps
Galaxy A3	10fps
Lenovo P2	10fps
Moto G4	7fps

GFXBench T-Rex

Phone	Score
Moto G5	15fps
Moto G5 Plus	23fps
Galaxy A3	19fps
Lenovo P2	22fps
Moto G4	17fps
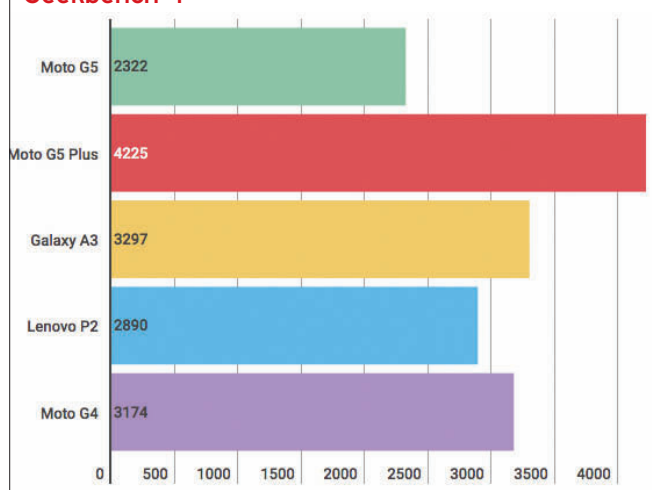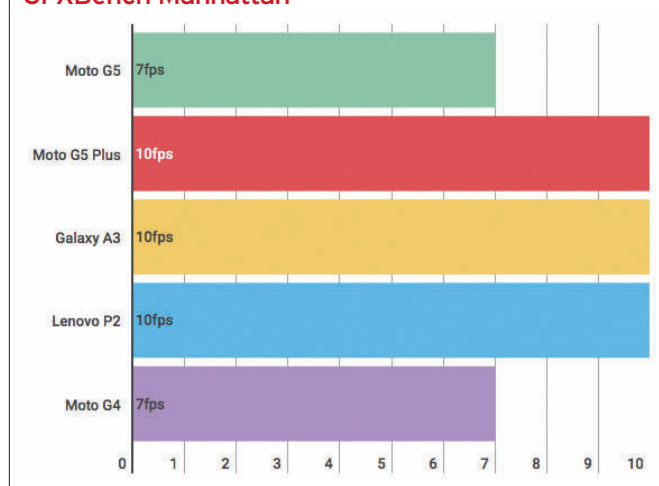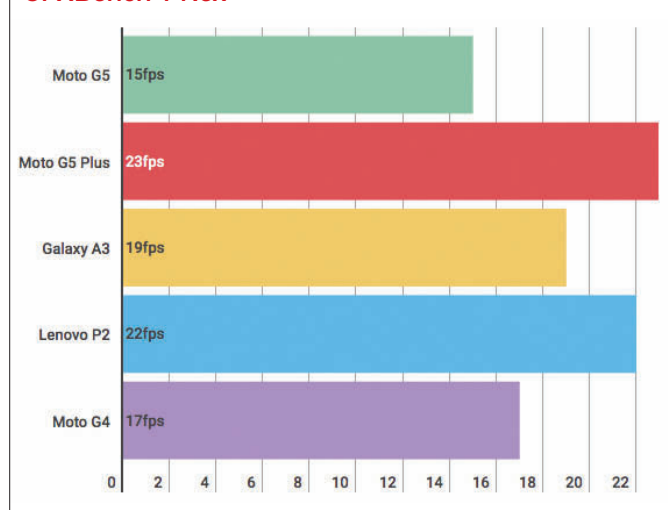
of which may be familiar from other Motorola phones, while others are entirely new. They're all optional, and are activated or deactivated from the included Moto app.

You can do a double 'karate chop' motion to turn on the torch, and quickly twist the phone backwards and forwards twice to activate the camera. Placing the phone face down on a table sets it do 'Do Not Disturb', while picking it up when it's ringing will silence the ringtone.

You can also swipe up from the bottom of the screen to shrink the display for easy one-handed use.

The most welcome addition is the use of the fingerprint sensor as a one-button replacement for Android's normal on-screen controls. You can now swipe left across the sensor to go back, tap it for home, and swipe right to open the list of recent apps.

It's an intuitive system and within seconds we were comfortably swiping away – it really speeds up loads of basic tasks, and is a feature not many other Android phones have yet. Occasionally, it can be a bit fiddly – registering your swipe as a press, or vice versa – but for the most part it works well, and it feels sluggish switching back to on-screen buttons. It's especially helpful here given the G5's relatively petite 5in screen – the extra screen real estate gained by removing the on-screen buttons makes the display feel more expansive than it really is.

Verdict

There's fierce competition in Android's mid-range market, but the Moto G5 is a strong contender. The build quality alone feels like it belongs on a much more expensive phone, while the fingerprint gesture controls genuinely improve the Android experience. The benchmarks and battery hold it back, but they're not unreasonable given the price – and you won't find a much better-looking phone at £169. You might want to spend the extra to get the Moto G5 Plus with more storage, a better camera and more. ⊠ **Dominc Preston**

The G5 takes clear and crisp photos

Specifications
9.7in (2048x1536, 264ppi) IPS display; Android 6.0 Marshmallow; Mediatek MT8176 processor; Hexa-core (2x 2.1GHz and 4x 1.7GHz) CPU; 4GB RAM; 32/64GB storage; microSD up to 256GB; Wi-Fi 802.11 a/b/g/n/ac, dual-band, Wi-Fi Direct, hotspot; Bluetooth 4.2; GPS; USB Type-C 1.0; 3.5mm headphone jack; 8Mp rear camera, autofocus, geotagging, touch focus, face detection, HDR; 5Mp front camera; panorama non-removable Lithium-polymer 5900mAh battery; 240.5x163.7x7.2mm; 430g

Build: ★★★★☆
Features: ★★★☆☆
Value: ★★★★☆
Performance: ★★★★☆

★★★★☆

TABLET

Asus ZenPad 3S 10 Z500M

Even if sales don't tell the same story, Android tablets struggle to keep up with the marketing clout of Apple's iPad. The latter are excellent tablets, some of the best out there, and benefit from their closed combination of hardware and software. Android tablets, on the other hand, are an often-ponderous product.

They remain more segmented and confused in their form and function than their smartphone counterparts. The combination of Google-based software and manufacturer-specific hardware means they are a varied market. For every excellent iPad contender, there is a genuine stinker. Asus is hoping it's made the former.

The ZenPad 3S 10 is similar to an iPad in name and looks, but is quite different in use. On the face of things, it is a stunningly thin, well-built 9.7in tablet that borrows a lot of design language from Apple's iPad Air 2. Much Like Samsung's Galaxy Tab S series, it's trying to present Android tablets as a viable high-end option. Does it succeed?

Design
Asus has done well in the design department. As an object, the 3S is one of the most ridiculously thin 9.7in tablets we've ever come across, thinner even than Apple's iPad Air 2. Much like that tablet, it has a glass front and aluminium body, weighs little and means the bold, vivid display is the main attraction.

The black and grey model we tested is even debatably too plain on the back; an Asus logo and camera

are the only things that break the grey. There is an oblong fingerprint sensor at the bottom of the screen as it's held portrait, with back and recent app capacitive buttons either side of it on the bezel. This is often preferable to on-screen buttons in Android that inevitably take up some of the precious display space.

Other than that, the left edge is clean save for the Micro-SIM slot, a 3.5mm headphone jack on the top, volume rocker and power/lock buttons on the right and a central USB-C port on the bottom in between the twin stereo speakers.

We can't shake the uniformity of it though, despite the thinness. This is tablet design 101, done well, admittedly, but with nothing out of the ordinary. Sure, it's hard to truly stand out with tablet design, but slates such as the Huawei MediaPad M3 and Sony Xperia Z4 are bolder. Then again, those two tablets are very hard to find in the UK.

The ZenPad 3S is pleasingly premium build for something in its price bracket, but despite all that it's not going to turn heads when you take it out on the bus.

Features
Processor
The ZenPad is powered by the Mediatek MT8176 chip, a hexa-core, 64-bit tablet specific processor. It's pretty efficient, though curiously refused to run the GFX Bench benchmarking app; it completely crashed the tablet. Not every user will be benchmarking, but it's odd and worth noting. It ran Geekbench 4 without any problems though, and we benched it next to the iPad Air 2 (see left). Remember Apple's tablet came out in 2014.

Storage and RAM
You have the option of 32- or 64GB storage with microSD expansion up to 256GB. That should be more than

Geekbench 4

Asus ZenPad 3S 10	3596
iPad Air 2	4010
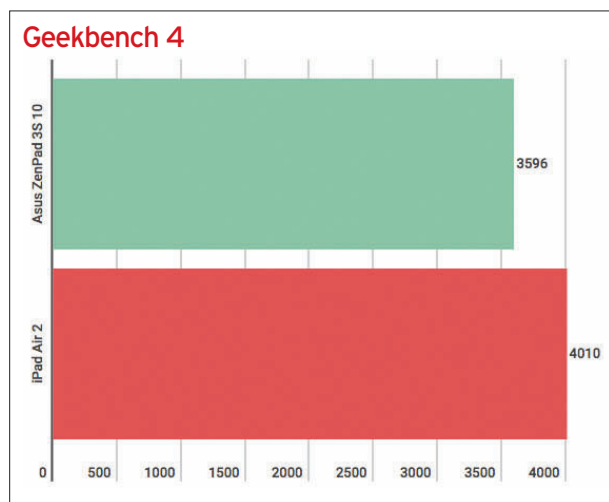
enough to load up with films, TV programmes and music.

Display and dimensions

Back to the thinness, then. It measures 240.5x163.7x7.2mm, and is 5.8mm at its thinnest point, where the frame is rounded. There's no doubt it's great looking. It houses a crisp, clear IPS LCD display with a resolution of 2048x1536 and 264ppi.

Asus calls it Tru2Life technology, but it's just generally very good at reproducing images and video. Streaming content on the ZenPad 3S Z500M is very enjoyable.

Cameras

The cameras are nothing to write home about, but then again they are hardly the marquee feature of a tablet (and it should remain that way). With a rear-facing 8Mp lens and a 5Mp front-facing camera, the latter is capable of shooting at 1080p – good news for video calling.

Battery

The Asus ZenPad 3S 10 has a generous 5900mAh battery that keeps it going for around three- or four days with light use, but obviously drops down if you hammer it with gaming, streaming and a few apps for work.

One thing we did notice was that it's very bad at charging from dead. On the few occasions it ran the whole way down, the included Quick Charge 3.0 charger took an absolute age to wake it up. This isn't rare for tablets, but here it was absolutely infuriating; blank screens, random battery icons and not turning on for at least 15 minutes.

Connectivity and extras

The ZenPad has all the extras you'd expect, even without the 4G SIM card tray that ours did include. Opt for the Wi-Fi version and you'll still get 802.11ac, Bluetooth 4.2, the fingerprint sensor, but not NFC. Not that

you should ever try to use a tablet for contactless payments.

Software

Frankly, the software lets this tablet down. For all the hardware effort, Asus's Android skin is ugly and not fun to use. And don't get us started on the bloatware.

If you are adept with operating systems it's possible, if a slog, to get this tablet running plain Android Marshmallow 6.0. Google's apps and services are far superior to Asus's and will make it usable. It's not that its own software or apps are completely unusable, they just make extremely well designed hardware feel cheap, buggy and downright boring to use. The joy of tablets, debatably even more important here than for smartphones, lies in the way they draw you into the operating system and make it as easy to use and intuitive as possible.

When you first boot it up, the ZenPad is a muddle of badly designed widgets, needless bloatware and an Android skin that

twists Google's stock option to breaking point with neon greens, blues and oranges. It's not well thought out at all. That said, if all you need a tablet for is Netflix, email and web browsing you probably won't mind, at this price. But for Asus to put so much effort into the beauty of the product when it's switched off, it's a real shame that we felt all that magic dissipate when we turned it on. We couldn't shake the disappointment.

Verdict

The Asus ZenPad 3S 10 Z500M is one of the best-designed pieces of tablet hardware we've yet seen. But the software made my time with it a chore, and we actively sought to not use it. That isn't good.

If you take the time to change the theme, delete a lot of apps and remember to keep it charged, then it could work for you. But you'll be put off by intrusive bloatware and an ugly operating system. Spend a bit more and get something better. ☒ Henry Burrell

Specifications
Nvidia GeForce GTX 1080 Ti GPU; codename Pascal GP102; 16nm process; 1480MHz (base) 1582MHz (boost) core clock; 11,000MHz memory clock; 352-bit memory bus width; 3854 processor cores; 224 texture units; 88 ROPs; DirectX 12, Vulkan APIs; GDDR5X 11GB RAM; Nvidia NVTTM Cooler; 1x 8-pin PCIe, 1x 6-pin PCIe 3x DisplayPort 1.4, 1x HDMI 2.0b; 16 simultaneous outputs; 2 card slots; 267x42x111mm; 3-year warranty

Build: ★★★★½
Features: ★★★★½
Value: ★★★★☆
Performance: ★★★★½

★★★★½

GRAPHICS CARD

EVGA GeForce GTX 1080 Ti Founders Edition
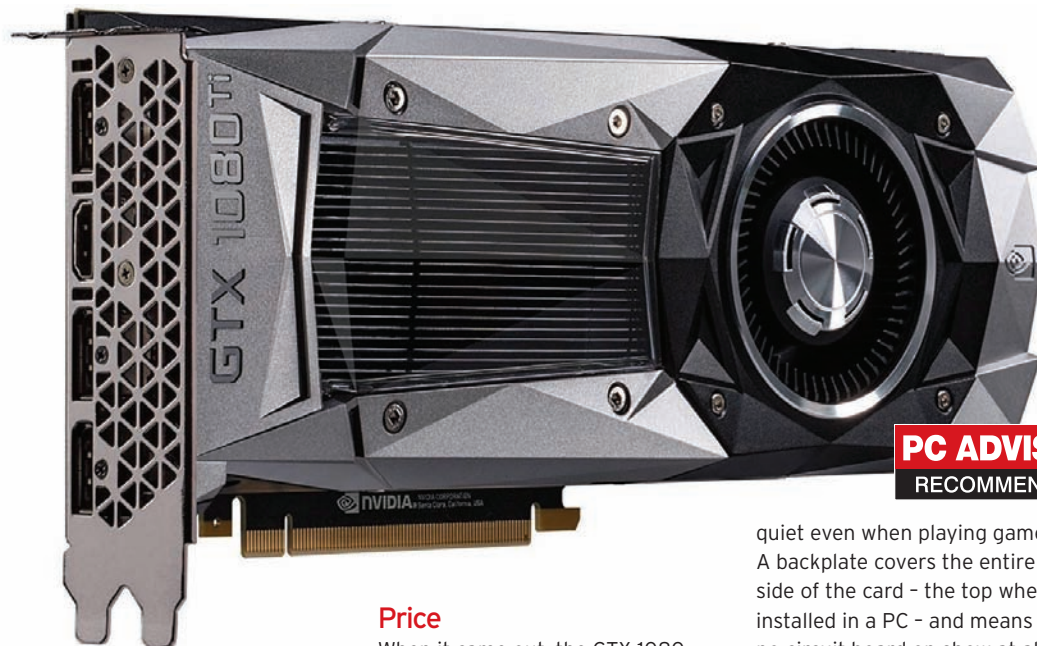
PC ADVISOR
RECOMMENDED

Before Nvidia announced the 1080 Ti, the performance king was the Titan X. That's no longer the case. The 1080 Ti is the fastest consumer graphics card you can buy right now, soundly beating the GTX 1080, too. Here we review the EVGA GeForce GTX 1080 Ti Founders Edition.

So what is the GTX 1080 Ti? Well, it's the pinnacle of what's possible with the Pascal architecture, at least for now. To look at, you won't immediately spot the difference between the Founders Editions of the 1080 and 1080 Ti as they both look the same, although they do have slightly different sets of video outputs. The 1080 Ti lacks DVI, but a DisplayPort to DVI-D adaptor is included in the box.

Price

When it came out, the GTX 1080 cost well over £600, with the Founder's Edition at £619. But the 1080 Ti's release has caused big price drops, and you can now pick one up for £489.

You can buy the EVGA GTX 1080 Ti Founders Edition for £699 from Ebuyer, so even though it's quicker than any GTX 1080 you're paying a good chunk more for that performance.

Features

Being the Founders Edition means the card sticks to Nvidia's reference design. It's good looking with silver highlighting and glowing green GeForce GTX lettering.

There's just one fan on the card, and it runs surprisingly

quiet even when playing games. A backplate covers the entire top side of the card – the top when installed in a PC – and means there's no circuit board on show at all. It also adds strength and dissipates heat. Nvidia is keen to point out that the card is built using premium materials including the die-cast aluminium body, and has a seven-phase dualFET power supply.

You'd be forgiven for assuming that the 1080 Ti is just a 1080 that's overclocked, but you'd be wrong. In fact, the 1080 Ti is really a tweaked GeForce Titan X – the card on which you'd have spent £1,000 to buy last year.

The two cards specifications are very similar, with the 1080 Ti using the same GP102 processor as the Titan X. The boost frequency is higher at 1.6GHz, and it has the same 3854 CUDA cores. RAM allocation is 1GB less at the odd amount of

	GTX 1080 Ti	GTX 1080	GTX 980 Ti
GPU	GP102	GP104	GM200
CUDA cores	3854	2560	2816
Boost clock	1582MHz	1733MHz	1076MHz
RAM	11GB GDDR5X	8GB GDDR5X	6GB GDDR5
RAM speed	11Gb/s	10Gb/s	3.5Gb/s
TDP	250W	180W	250W
Power connectors	1x 8-pin, 1x 6-pin	1x 8-pin	1x 8-pin, 1x 6-pin
Outputs	3x DisplayPort 1.4, 1x HDMI 2.0	3x DisplayPort 1.4, 1x DVI, 1x HDMI 2.0	3x DisplayPort 1.4, 1x DVI, 1x HDMI 2.0

3DMark Fire Strike Ultra

EVGA GTX 1080 Ti FE	6499
Nvidia GTX 1080 FE	5043

(scale: 0, 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 5500, 6000)
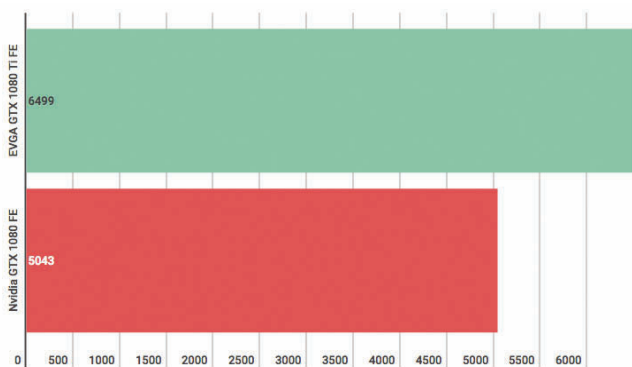
Alien: Isolation 1080p Ultra

EVGA GTX 1080 Ti FE	246
Nvidia GTX 1080 FE	229

(scale: 0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240)

Thief 1080p Ultra

EVGA GTX 1080 Ti FE	86
Nvidia GTX 1080 FE	86.6

(scale: 0, 10, 20, 30, 40, 50, 60, 70, 80)

VRMark Blue Room

EVGA GTX 1080 Ti FE	2963
Nvidia GTX 1080 FE	2242

(scale: 0, 200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800)
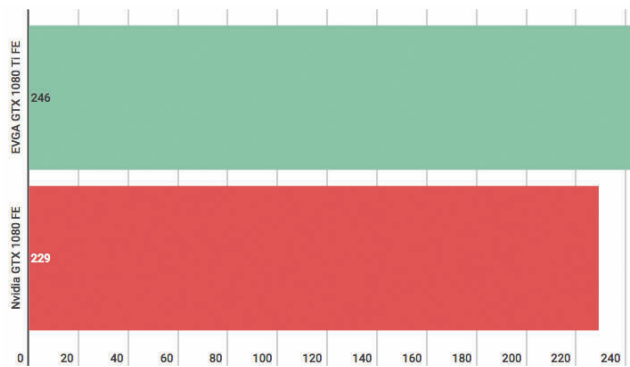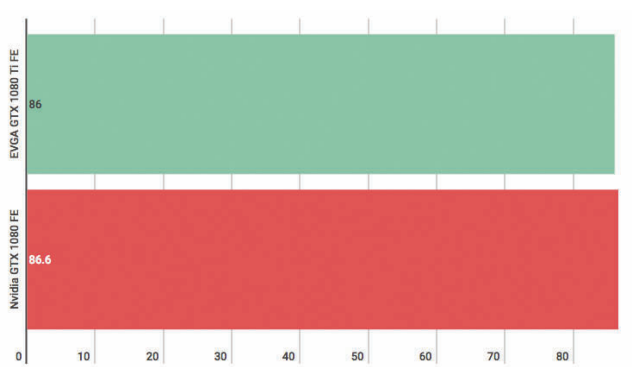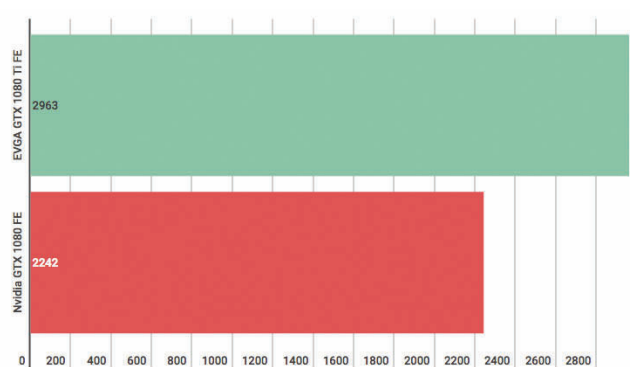
11GB, but it runs 10 percent quicker at 11GHz. These higher frequencies are likely thanks to that improved dualFET power supply. The table opposite is a quick summary of how it compares to the 1080 and its predecessor, the 980 Ti.

So, the 1080 Ti makes the Titan X irrelevant for gamers, as it is £300 cheaper. But it doesn't make the 1080 irrelevant, mainly thanks to its large price drop, which makes it much better value than before.

The 1080 Ti is faster, but unless you want to pay that extra £200 to turn up the quality to maximum at 4K or run a multi-monitor set-up, you could easily get away with a 1080 and still play at 4K.

If you're coming from a GTX 980 Ti, the 1080 Ti is – in some cases – twice as fast. On average, it's roughly 60 percent quicker. That's a massive increase, and you will need that extra performance if you've just bought a 4K monitor or a VR headset. But, as we've said, you'll still enjoy around a 30 percent boost by upgrading to the cheaper 1080. Plus, the 1080 uses around 70W less than the 980 Ti and 1080 Ti, which might be a big advantage if you're running near the limit of your power supply's wattage.

Performance

We used a slightly different test rig than our usual one, so we can't compare performance to other graphics cards we've reviewed. But we did retest the GTX 1080 alongside the Ti so you can see exactly how much quicker it is in some popular benchmarks and games (see above). The rig has 16GB of DDR4 RAM, an Intel Core i7-4770K CPU, an Intel motherboard and a Crucial BX200 240GB SSD.

Should you buy a GTX 1080 Ti?

Clearly this is a very fast graphics card. But buying one right now is perhaps not the most sensible thing to do. AMD's Radeon RX Vega cards will launch in a couple of months, and could – as Ryzen has done for

Intel processors – make Nvidia's offerings look expensive. But until we know how fast the flagship Vega card goes, we can't know for sure. If you absolutely have to buy a graphics card right now, the GTX 1080 Ti is an excellent choice.

Verdict

The GTX 1080 Ti Founders Edition is expensive, but offers stunning performance. Manufacturer overclocked versions will arrive soon and may be better value, but you can overclock the card easily yourself. If you're not planning to buy a VR headset, you can save money and buy a GTX 1080, but if you can afford it, the 1080 Ti still offers good value and will be more future-proof. ⊠ **Jim Martin**

Specifications
24in (1920x1080, 92ppi) TN matte display; 16:9 aspect ratio; 60Hz refresh rate; 14ms response time; 250cd/m² quoted brightness; 240.6cd/m² tested brightness; 1000:1 static contract ratio: 1000:1; 750:1 tested contrast ratio: 750:1; 98 percent tested sRGB; 77 percent tested AdobeRGB; 1.98 tested Delta E; DisplayPort; HDMI; VGA; headphone out; 540x495x230mm (including stand); 100x100mm VESA mount; 3.3kg; 2-year warranty

Build: ★★★★☆
Features: ★★★½☆
Value: ★★★★½
Performance: ★★★★☆

★★★★☆

FLAT-PANEL DISPLAY
BenQ GW2406Z

In recent years, AOC has been the go-to brand if you wanted a cheap IPS PC monitor. But other manufacturers have been quick to release their own models, and BenQ's new GW2406Z should prove tempting at just £120.

Design
The GW2406Z isn't aimed at gamers specifically – IPS screens don't have the fast response rates of TN panels. But for casual gamers it will be fine. Instead, this is a 'general use' screen that's going after those that want a good-looking monitor and the kind of ultra-thin bezels we're starting to see on laptops. Note that the display itself doesn't go right to the edge of the panel, but stops a few millimetres before it, so the total bezel width is around 10mm, but has the appearance of 5mm.

This thinning down appears to have just one drawback: the power supply is external. But it's a minor inconvenience if you can hide it out of sight somewhere under your desk. At this price you wouldn't expect a fully adjustable stand, and you don't get one. The screen tilts up and down, but that's it.

It does have three inputs: DisplayPort 1.2, HDMI 1.4 and VGA D-Sub. There's a headphone output that routes audio from the HDMI or DisplayPort inputs, but there are no built-in speakers. VGA and HDMI cables are bundled in the box.

The 24in panel has the expected 1920x1080 full-HD resolution, but BenQ lists it as an AH-IPS panel. This stands for Advanced High-performance IPS, but essentially it is the same as other IPS screens.

You won't find many image controls in the on-screen menu, such as gamma or colour temperature presets, but the essentials are there. Using the OSD is a pain because, as with so many monitors, the button labels are almost invisible. And the five buttons in the bottom edge all feel the same to your fingers, so it's all too easy to press the power button instead of the menu button.

Performance
Considering the price, image quality is decent. Attaching our Spyder5Elite colorimeter, we measured a maximum brightness of 240.6cm/m² and contrast of 750:1 (lower than the claimed 250cd/m² and 1000:1), but at least contrast remained the same no matter the brightness level.

At the recommended brightness of 120cm/m², the black level of 0.25cd/m² isn't amazingly inky but – again, for the price – it's perfectly workable.

The average Delta E of 1.92 is towards the higher end of what we like to see, but in general colours and greyscale are accurate.

Using the Spyder to calibrate the screen we saw a final gamma of 2.26, which is fairly close to the ideal of 2.2. But the out of the box settings are not far off that, so you won't necessarily need a calibrator.

The 2406Z covers 98 percent of the sRGB gamut, 77 percent of Adobe RGB and 74 percent of NTSC. This, along with the reasonably accurate out-of-box colours, means it's a good budget choice for editing photos and colour-correcting video, although not if this needs to be done to professional standards.

Contrast is good enough, and thanks to the IPS panel, viewing angles are very good both horizontally and vertically.

What this means is that, unlike cheap TN monitors, you won't be tilting the screen back and forward to try to figure out which emails are read and unread – the subtly different shades are easily discernible on the BenQ. It also means minimal colour shift and brightness drop-off if you're not viewing the display square on. But if you like to play a lot of fast-paced games, you might be better off with the similarly-priced AOC G2460VQ6, which has a 75Hz TN panel.

Verdict
If you're after a monitor with good colours and contrast, but aren't bothered about fast response times for gaming, the GW2406Z is a great budget choice. ⊠ **Jim Martin**

Specifications
1.34in (320x300) always-on transflective colour LCD touchscreen display; 1.2GHz Core processor; 4GB storage; 512MB RAM; Bluetooth 4.0; Bluetooth Edge; Wi-Fi; battery life: 5 days regular use/11 days basic use; IP67, resistant to water and dust; optical heart-rate sensor; 280mAh battery; GPS; GLONASS; 54.5g

Build: ★★★★☆
Features: ★★★½☆
Value: ★★★★☆
Performance: ★★★½☆

★★★½☆

ACTIVITY TRACKER
Amazfit Pace

The Amazfit Pace is high-end on specs, but pleasingly not so on price. It packs GPS with run tracking, a heart-rate monitor, music controls and more – so does the cheaper price mean it cuts some corners? The answer is yes, but not in the worst ways possible.

Design
The Pace might not be to everyone's tastes design-wise, but if you're into your reds and blacks, then you'll be fine. AFC Bournemouth fans will be laughing. Past that, the watch has a surprisingly decent look and feel for its price point. Leaving cost aside, we used the black with red colour option and liked the circular metallic rim around the face, giving it a near premium feel.

The rear casing that sits next to the wrist is comfortable to wear (Amazfit says it is ceramic), and has four flat connectors for the proprietary charging dock. These sit above the heart-rate sensor, while the standard 22mm strap connectors hold a rubberised band that's fine for work and for excessive sweat when exercising.

The screen and body aren't tiny, but it never felt like it dwarfed this writer's relatively small wrists. The screen also has a flat tyre effect that is annoying on smartwatches. But because the entire screen has a thin black rim between it and the metallic rim, you don't really notice it. Then again, it's a shame that the screen doesn't reach fully to the edges of its own casing.

The ceramic, metal and rubber combination is a winner for the Pace. As long as you like the colour options, this is an attractive watch with a decent, reassuring weigh to it.

Features
The circular display is 1.34in across with a 320x300 resolution. A neat trick is its always-on transflective colour LCD. Watches rarely do always-on exactly right, and it's the same here. Think of it like a screensaver, where power consumption is reduced by dumb projection. The Pace will still tell you the time and all your stats on the watch face in always-on mode, which turns on after a period of inactivity. The only way to come out of the

mode is to press the only physical button on the watch, which is on the right at two o'clock. It's a small niggle, but not being able to tap the screen or turn a bezel to wake is a tad less convenient and intuitive.

The screen also has trouble with auto-brightness. This is on by default and you can't override to select a preferred constant brightness level. Therefore in bright sunlight, the screen is very hard to read. The always-on display is also darker, so you may think at first, like we did, that there is a fault.

The 1.2GHz core processor and 512MB RAM keep things ticking over nicely, and there is rarely significant delay when browsing menus, selecting functions or using GPS tracking. The vibration motor is noticeable, but not the strongest we've ever experienced on a watch.

The Pace has Bluetooth 4.0, essential to connect to your iPhone running iOS 9 and later or Android phone running 4.4 and later. There's also the option to connect to a Wi-Fi network, which you can use to wander out of Bluetooth range in your house or at work and still stay connected to your phone. You need Wi-Fi to update the software.

It is rated IP67, the same as gadgets such as the iPhone 7, which means its resistant to water and dust, just don't take it swimming or in the shower for too long.

The on-board battery is 280mAh and is pretty good at keeping the Pace powered. No one uses a smartwatch with all the functions turned off, but we comfortably got three days out of it, even with constant Bluetooth on connected to an iPhone and intermittent GPS use to track runs.

Software
Maddeningly, you can't view GPS data anywhere but on the watch face – you can't even look at it in the iOS or Android Amazfit app that you sync the watch with. This means GPS records are only on the 4GB

hard drive of the watch and meant that we never bothered fiddling about looking at them.

Other running watch set-ups let you take a deeper look at stats on your workouts, whether that's on your phone or computer. Here, the cool little map of where you ran is just a squiggle on a watch screen, with no map behind it. It's frustrating and means you will never really be able to see if you've improved by looking at the raw data.

This is a real shame because the Pace excels at GPS data collection when out running or on a workout. You can record run, walk, indoor run, bike, indoor bike and trail run. It's fairly easy to pause and record workouts once you've got used to the touch only inputs of the screen, waking it first with the button. Swipe right to go back on menus and you're sorted.

Also included when swiping left on the home screen is activity progress. Heart-rate graphs, weather, music, alarms, compass, stopwatch and sleep tracking. This is a healthy number of functions for, sorry to say it again, the price. There's a lot here, but it doesn't work on apps; you can't close stuff to make it run faster. Either way, overall, the interface is well designed but slow and has one too many bugs. A recent software update has improved things slightly, though.

Verdict
The Amazfit Pace is a solid entry point for those curious enough to want to record their exercise without spending a month's rent to do so. ⊠ Henry Burrell

BEST PCs FOR

I n March, AMD launched its much-anticipated Ryzen processors. We've written plenty about them over the past couple of issues, but now we're in a position to see how they fare when viewed as part of a whole PC.

For this group test, we asked some PC builders to send us their best system based around a Ryzen chip and others to use something from Intel's seventh generation Kaby Lake range.

It's no secret that games run better on Intel processors at the moment, despite Ryzen's better performance in many CPU-based tests. The fact is that although you get more cores for your money, most game developers have not yet optimised their titles to work well on Ryzen.

Because of the lack of competition from AMD in recent years, studios have tended to optimise for Intel processors, and there's no guarantee that your favourite games will ever be updated so they run faster if you have a Ryzen chip.

But as we explain on page 77, this doesn't mean you shouldn't buy a gaming system with a Ryzen processor.

As Overclockers UK demonstrates, you don't have to spend top dollar to get a PC that will handle the latest games. And it will be plenty quick enough for all the other stuff you need to do besides gaming.

Buying advice

The reviews will tell you all you need to know about each PC, but here's some extra advice to help you choose the best PC for you.

Processor

Different games place different demands on your computer hardware, but choosing a gaming rig will involve a balancing act between CPU and graphics performance.

For gaming PC's we're happy to allow overclocked processors, which will significantly increase your overall processing power without having to stump up for the most expensive chips.

To keep the overclocked processors cool, most PC builders fit third-party coolers, some using the traditional heatsink and fan design, while others opt for a liquid coolant pumped through a radiator. This is known as a closed-loop cooler or CLC for short.

Overclocked processors place additional demands on the system's power supply and also require better cooling, so expect

Photography by Dominik Tomaszewski

PC ADVISOR TEST CENTRE

GAMES

For the ultimate gaming experience you need a powerful PC. Paul Monckton tests out five of the latest and best

to pay more for PCs with more extreme overclocking. You can overclock the processor yourself if you wish, but it can be a good idea to buy a pre-overclocked system such as the ones reviewed here, which are covered by the manufacturer's warranty when running at the higher speed.

Motherboard

There are several points to consider when choosing the right motherboard for your PC, if you're not into technical details you may be tempted to overlook the motherboard and concentrate on the processor and graphics, but the motherboard is extremely important.

All AMD Ryzen processors are overclockable, but only motherboards with the X370 and B350 chipsets support this.

You should also try and get a board that supports the latest USB 3.1 gen 2 sockets (which run at 10GB/s) and has a high-performance PCI-Express M.2 SSD slot.

Premium motherboards such as these may offer additional features such as the higher-quality built-in audio and faster network cards designed to reduce lag alongside nice, but unnecessary, things like better looks and even colour-changing LEDs,

Graphics card

It's usually the graphics card that determines the overall quality of your gaming experience. Once your processor is fast enough, it's down to the card to deliver the game to your screen. This is why we suggest gamers go for a Core i5 or Ryzen 5 processor rather than the more expensive Core i7 as the difference in price will almost certainly serve you better spent on the graphics card rather than on the CPU.

To ensure the smoothest possible gameplay, you generally want to achieve a minimum of 60 frames per second (fps) in your game. This is the limiting speed of most PC displays, so you won't really need to go faster than this unless you have a high-speed gaming monitor that allows for faster refresh rates. Any extra performance will then allow you to increase the quality

settings in your game, making characters sharper, textures more realistic and graphical effects more immersive.

Right now, Nvidia offers the fastest cards (at high prices), but AMD also has some great-value offerings such as the RX 480. That's just been superseded by the RX 580, which is a bit quicker for similar money, so ask to upgrade to this if you order the Overclockers UK machine.

Monitor

The PCs here don't come with monitors. If you don't have a good one already, then, for more immersive gameplay, opt for the largest display you can find and one with a good contrast ratio. A fast response time will ensure that fast, frenetic gameplay remains free of blur, although not all game players will notice any difference.

TN-based monitors will cost less and provide most of these features, but IPS-based displays will give you better overall colour reproduction and wider viewing angles, although response times tend to be slower. For a more responsive display, go for a gaming monitor with a high refresh rate of 120- or 144Hz, although you'll need powerful graphics to supply frames at this speed. For the very smoothest gameplay from an Nvidia graphics card, look for a monitor that supports Nvidia G-sync. With G-sync, the monitor stays in step with the graphics card rather than the other way around.

This means less blurring or image tearing even at lower frame rates and will be of great benefit to mid-range graphics cards such as the ones found in these PCs. AMD offers a competing technology called 'FreeSync' and these monitors are generally a lot cheaper than G-sync ones.

Peripherals

If you're using your PC on a desk with a monitor, you'll benefit from the improved responsiveness of wired rather than wireless devices. Look for high-resolution mice, and keyboards with programmable keys and backlighting.

High-grade mechanical switches in keyboards have a better 'feel' and provide longer life than cheap membrane switches. Some draw attention to the W, A, S, D keys with a different colour or texture. A gaming sound card can provide a more immersive experience by adding multiple sound effects, with improved audio fidelity. Also consider a gaming headset with a built-in mic.

However, if you're planning on playing from the sofa, you'll want wireless controllers. For keyboard input, we would recommend a wireless model that comes with an integrated pointing device, such as a trackball or trackpad.

We're not used to seeing many gaming PCs coming with optical drives these days, and none of this month's PCs have one. If you're still playing games delivered on disc, you may need a USB optical drive – some of the latest cases don't even have a bay for an internal drive.

Power consumption and noise

If you're using the PC as a home entertainment hub, you'll want to consider idle power consumption and noise. The more you overclock your PC, the more power it will consume and the louder it will get.

Warranty

Warranty terms are crucial when it comes to gaming PCs and a key advantage of buying a pre-built overclocked PC is that all of the overclocking will be tested and covered by the vendor's warranty. The longer the better, but also look for a collect-and-return rather than return-to-base option. Also pay attention to whether parts and labour are both covered and for how long.

> To ensure the smoothest possible gameplay, you generally want to achieve a minimum of 60 frames per second (fps) in your game, which is the limiting speed of most PC displays

CHILLBLAST FUSION ADAMANTIUM 3

£1,549 inc VAT • chillblast.com

Compact in size, but big in performance, the Chillblast Fusion Adamantium 3 shows that you don't need an eight-core processor to get smooth ultra-high definition gameplay. Based on the top-of-the-range Intel Core i7-7700K Kaby Lake processor and a high-end Nvidia GTX 1080 graphics card, this system still holds its own against the new AMD Ryzen 7 based PCs.

Design

Chillblast's compact and not-quite cuboid Cit Mesh Kube case sits lower and wider than a regular tower PC and has been designed to sit unobtrusively in a living room setting while delivering maximum performance, but with the minimum noise and power consumption.

Finished in matte black, with blue accents, the Fusion Adamantium 3's appearance is rather understated compared to many gaming systems we've seen recently. It does contain interior lighting and a transparent viewing panels at the side, but the soft blue lighting effects are rather subtle compared to the full-colour light shows of some competing systems.

> Finished in matte black, with blue accents, its appearance is understated compared to many gaming systems we've seen recently

Behind the mesh covering at the front of the case sits a huge 200mm fan with blue LED illumination. This is complemented by a single 120mm fan at the rear and the two work together to keep the whole system cool with minimum noise, spinning up and down automatically as necessary. The case has space for an optical drive, although none is installed and a handy built in memory card reader, which is great for fans of photography.

Although there's less room inside than you'd get with a mid-tower size case, the internals aren't cramped and it's easy to work on the internals of the PC when you need to. Removing the top of the case allows access to the motherboard, which is mounted horizontally inside, with additional access available by removing the side panels.

Processor and graphics

Based on Intel's formidable Core i7-7700K Kaby Lake CPU, the Fusion Adamantium 3 delivers single-core speeds of up to 4.5GHz, giving it a distinct edge when it comes to gaming and other applications that aren't optimised for the large numbers of cores you'd get in a Ryzen system. This is coupled with a high-end Zotac-branded Nvidia GeForce GTX 1080 graphics card. Once the flagship model of the GeForce range, the GTX 1080 is powerful enough to deliver 4K gameplay and now available at a more affordable price.

Despite using an unlocked 'K' edition processor, Chillblast has chosen to exploit the power efficiency of the Kaby Lake architecture by designing a cool and quiet PC suitable for living

In keeping with the cool and quiet concept, the Fusion Adamantium 3 makes use of the motherboard's built-in fan control options

room use, rather than aggressively overclocking the processor to get the absolute maximum performance.

Storage

Two separate drives each provide a sensible combination of super-fast and high-capacity storage. The super-fast storage comes in the form of a 256GB Samsung SM961 NVMe SSD. This is the OEM version of Samsung's 'Polaris' PCI-Express SSD product line, capable of around six times the performance of the best SATA SSDs.

Because 256GB isn't enough disk space on its own, Chillblast has also included a roomy 2TB hard drive for less performance-critical storage. These core components, plus 16GB of DDR4 memory, are all installed in an Asus Prime Z270M-PLUS motherboard.

This mATX form factor motherboard, is itself the source of some of the LED lighting, which can be seen through the side of the case. The PCI-Express slots pulse with a warm glow, offset by the cool blue lights from the graphics card and main case fan.

The motherboard supports up to two M.2 SSDs in SATA or NVMe mode and is also ready for Intel Optane memory. It comes with PS/2 mouse and keyboard sockets at the rear as well as two each of USB 3.0 and 2.0 ports and single 5Gb/s USB Type-C connector. There's also eight-channel analogue audio and a single Gigabit LAN port.

In keeping with the cool and quiet concept, the system makes use of the motherboard's built-in fan control options, which tie in with Asus's optional overclocking and management software.

Performance

As you'd expect from a PC fitted with a high-end CPU and a GeForce GTX 1080, the Fusion Adamantium 3 delivers gaming performance in spades. Older games such as Thief and Alien: Isolation benchmark at over well over 60fps at 4K resolution in High or sometimes even Ultra quality settings. With a more demanding title such as Deus Ex Mankind Divided, you'll be hitting 30fps in 4K Ultra mode, which

is fine for playing on the living room TV and if you do want super smooth 60fps action, you'll be able to get that by stepping down to 2560x1440 on your PC monitor.

The Core i7-7700K may not be overclocked, but it still delivers a lot of performance for all your non-gaming needs. You'll be able to achieve workstation-like performance in tasks such as photo and video editing, which is excellent across the board. The CPU is helped here by the super-fast NVMe storage.

If you're still hungry for a little more speed, you can purchase the PC factory overclocked by Chillblast to 4.6GHz at no extra charge. This will however affect noise and power consumption.

The only area where the CPU may lose out is in extremely parallel processing environments, where an eight-core processor, such as an AMD Ryzen 7, may pull ahead. You can see this effect in our Cinebench R15 tests, where the single-core test is excellent, but the multi-core test lags a long way behind Ryzen chips. This does not affect games however, which still currently benefit much more from high performance per core rather than multi-core power.

Intel-based PCs currently achieve better performance from NVMe storage devices than AMD-based systems, too.

Warranty

The Fusion comes with Chillblast's excellent two-year collect and return warranty which extends to five years for labour only. It also comes with lifetime phone support.

Verdict

The Fusion Adamantium 3 Gaming PC delivers high performance in a compact form factor, while making the minimum noise. Higher performance is available at no extra charge via an optional overclocking option, but not without compromising it's 'cool and quiet' design philosophy. You won't be expanding it with dual graphics cards, but it's also reasonably priced for a PC of this specification.

If you're still hungry for a little more speed, you can purchase the PC factory overclocked by Chillblast to 4.6GHz at no extra charge

Build	★★★★★
Features	★★★★☆
Performance	★★★★☆
Value	★★★★☆
Overall	★★★★☆

MESH RYZEN 7 GAMING PC-A

£1,600 inc VAT • meshcomputers.com

Large, imposing and featuring a customisable built-in light show, the Mesh Ryzen 7 Gaming PC-A delivers stunning build quality with striking tempered glass panels and the latest AMD processor technology inside.

Design

This is an imposing beast of a PC even before you turn on the power thanks to tempered glass side panels, which give a clear view of the components inside. These include the latest AMD Ryzen 7 1700X eight-core processor and a powerful Nvidia GTX 1070 graphics card.

The Thermaltake View 31 tempered glass RGB Edition Mid Tower chassis into which the system is built is a heavy, expensive-looking case that sits wider than the typical mid-tower PC and is fitted with glass side panels which let you see every single internal component from both sides. It also contains a trio of 140mm fans at the front, which can be set to any of 256 available colours which glow through meshed front of the case. Another set of these same illuminated fans is also fitted to the top of the case.

Taking advantage of the glass panels, Mesh has ensured that most of the rest of internal parts also support RGB illumination: firing up the PC for the first time results in the kind of sensory overload you'd get from turning on a set of Christmas lights without taking them out of the box. LEDs hit you from all directions, gradually transitioning through a rainbow of gaudy colours, giving the PC a second function as a sort of high-tech lava lamp replacement.

Thankfully, whether these effects appear garish and jarring or rather more subtly engaging is entirely up to you, as the whole

lot can be customised to your own preferences under software control. Keep the glass clean of fingerprints and the system really can look rather impressive.

On a more practical level, the case's modular design allows for a variety of internal configurations and comes with removable dust filters, which are especially important when the PC's internals are constantly on show.

Processor

The Ryzen 7 1700X processor sits in the middle of AMD's Ryzen 7 range and features eight cores and 16 threads at 3.4GHz, boosting to a maximum 3.8GHz for an individual core. The processor is topped with a tidy-looking Corsair H60 Hydro Series liquid cooler and the whole PC is powered by a 650W Corsair RM650x PSU.

An Asus AMD AM4 Ryzen PRIME X370 Pro motherboard forms the basis for this PC build. This is an advanced motherboard with support for both Nvidia SLI and AMD CrossFireX dual-graphics configurations, enhanced audio hardware, 10Gb/s USB 3.1 support and a slew of overclocking and fan control options. Also key to this particular system is its support of Aura sync RGB lighting which can coordinate the various illuminated components in the system

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Taking advantage of the glass panels, Mesh has ensured that most of the rest of internal parts also support RGB illumination

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and place them under the control of a single software application offering preset effects modes and user customisation.

The motherboard's M.2 slot is filled with a 250GB WD Blue SSD, and this is unfortunately a rather disappointing feature in what is an otherwise impressive gaming PC. Using an M.2 SSD is a great idea as it requires no cables and only a tiny amount of space, but a drive based on out-dated SATA technology rather than a much faster NVMe model is, we feel, rather less than a PC at this price point would deserve.

A Samsung 960 Evo NVMe drive would cost around £50 more, but deliver far greater performance. While the cost saving may be worth it to some, it seems a strange one to make as Mesh has installed Windows 10 Pro rather than the Home edition, wiping out any cost saving made on the SSD and delivering no real benefit to most gamers. The PC is also supplied with a separate 1TB hard drive, where many other systems at this price might give you 2TB.

Of course, the GTX 1070 graphics card selected for this system is an Asus STRIX ROG model, with matching RGB lighting support, although it's not the factory overclocked version.

Performance

As with all Ryzen 7-based PCs the Mesh Ryzen 7 Gaming PC-A comes into its own when performing many tasks simultaneously or exploiting the kind of parallel processing algorithms found in workstation-class software such as Cinebench R15. Unfortunately, this doesn't translate into the best gaming performance results, although the system is certainly quite competent, you could certainly achieve better frame rates at this price, especially if you're willing to sacrifice some of the, admittedly impressive, cosmetic enhancements offered by this PC.

There's also the reduced storage performance you get from the SATA SSD which is reflected in the system's rather low PCMark 8 Storage score and also has a detrimental effect on the other PCMark scores too. While this has no bearing on those all-important gaming frame rates, it will increase loading times on larger titles.

The included GTX 1070 graphics card is a good choice, offering solid performance results at high resolutions and quality settings. But, because it isn't factory overclocked, it's not achieving the very best results we've seen from other GTX 1070s. It does, however, come with software tools to overclock it yourself, which should enable you to eke out some extra frames per second when you need them.

Overall, then, performance is good, but it could be better. If you like this PC we'd suggest you consider customising the build slightly to speed it up a bit, especially if you don't need Windows 10 Pro.

Warranty

Mesh offers a lifetime warranty on labour, but parts are only covered for the first two years. For the first year only, a full collect and return service is provided. Much better warranties are available elsewhere.

Verdict

The Mesh Ryzen 7 Gaming PC-A is beautifully built, but ultimately flawed in its configuration. Let down by a slow SSD and a non-overclocked graphics card, yet coming with an unnecessarily expensive operating system, we feel this PC could do much better with a couple of minor tweaks to the specification.

OVERCLOCKERS UK TITAN FALCON

£1,260 inc VAT • overclockers.co.uk

The Titan Falcon from Overclockers UK is a tremendously powerful, yet reasonably-priced gaming PC packed with AMD's newest tech. It saves money by taking AMD's new entry-level Ryzen 7 1700 processor and overclocking it to 3.8GHz to deliver performance similar to more expensive Ryzen 7 chips.

Design

The Titan Falcon is housed in a Cooler Master MasterBox 5 system case with a matte black finish inside and out, flexible internal mounting options and convenient cable management. Built-in 120mm cooling fans are fitted front and rear, and a removable dust filter protects the power supply at the bottom.

It's not the fanciest of cases, but the transparent side panel gives you a good view of the internal components, which glow in red and blue, thanks to LEDs built into the motherboard and graphics card, as well as a dedicated LED strip light.

Other than that, there's not much to be seen inside as the 2TB Seagate Barracuda hard drive and 650W Cougar VTX 650W 80 Plus Bronze power supply are hidden from view in their own compartments at the bottom of the case, with the cable management concealing any unsightly wires.

The hard drive is supplemented by a super-fast 256GB Samsung SM961 NVMe PCI-Express SSD, which holds the operating system

Build	★★★★☆
Features	★★★★★
Performance	★★★☆☆
Value	★★★★★
Overall	★★★★☆

> **The Titan Falcon's transparent side panel gives you a good view of the internal components, which glow in red and blue**

and any other data which may need frequent high-speed access. Powering the system, the Ryzen 7 1700 gives you eight processor cores, delivering a total of 16 processing threads for smooth computing, no matter how many applications you run at once. Because this particular chip has been overclocked to 3.8GHz, it gives you the performance of a faster Ryzen 7 without the corresponding increase in price.

Sticking with the AMD theme, Overclockers has opted to use a Sapphire Radeon RX480 Nitro+ OC graphics card in this PC. It's a factory overclocked model, which offers a little speed boost over the standard RX480 and comes with dual cooling fans and a backplate as well as the LED illuminated logo mentioned earlier.

These components, along with 16GB of 2400MHz RAM, are assembled in an Asus Prime B350-Plus motherboard, which comes with comprehensive overclocking and fan control options as well as enhanced gaming audio, 10Gb/s USB 3.1 and built-in LED illumination. The B350 chipset used here is the poor cousin of the X370 chipset found in some more expensive systems, but it's quite capable of a reasonable amount of overclocking. If you're intending on pushing Ryzen 7 right to the very limit though, you may be better off investing a pricier X370-based motherboard. You'll definitely need one if you're thinking of going with dual Nvidia graphics cards at any point in the future.

However, the Asus Prime B350-Plus is a perfectly competent selection for this PC, in keeping with the philosophy of delivering top performance without a correspondingly high price tag.

Performance

Despite being fitted with the lowest specified Ryzen 7 chip, the Titan Falcon performs rather well, thanks to its pre-overclocked processor. Being an eight-core CPU it naturally shines when given heavily multi-threaded tasks such as the Cinebench R15 Multiple CPU test where it actually outperforms PCs based on the Ryzen 7 1700X in some cases and, of course, blows away any Intel-based quad-core system.

However, we're primarily interested in the PC's gaming performance, and here the performance of the Ryzen 7 chips can't match the best that Intel has to offer – for now, at least.

Most of the available gaming performance is down to the graphics card of course. Fitted with the RX480, the Titan Falcon is confidently capable of 60fps Ultra-quality gaming at 1080p, although it does start to struggle a little when confronted with Deus Ex: Mankind Divided. Stepping down to High quality brings the benchmark back to 60fps fluidity.

If you want better gaming performance, you can specify the Titan Falcon with a more powerful graphics card. For an extra £250 you could configure the system with a much faster Nvidia GTX 1080. This would give access to 2560x1440 or even 4K resolutions while keeping the overall system price competitive, thanks to the cost savings achieved through the overclocked CPU and B350 chipset motherboard.

The Samsung SM961 NVMe SSD is also a great boost to general performance which helps boost non-gaming benchmark scores above systems based on older SATA technology.

Warranty

Overclockers offers an excellent three-year collect-and-return warranty which is one of the best available in the industry, covering parts and labour for the whole three-year term. This is particularly valuable when investing in an overclocked PC with components pushed to their limits.

Verdict

The Overclockers Titan Falcon embraces the spirit of overclocking by boosting the performance of lower-specified components to match their more expensive counterparts, but without the higher price and all backed by a superb three-year warranty.

This overclocked Ryzen 7 1700 system occasionally outperforms those based on the pricier 1700X chip and makes no sacrifices on build quality. You may wish to upgrade to a more powerful graphics card for resolutions above 1080p, but the price will remain highly competitive.

The Overclockers Titan Falcon embraces the spirit of overclocking by boosting the performance of lower-specified components

WIRED2FIRE PYRO RYZEN DG

£1,675 inc VAT • wired2fire.co.uk

Based on one of AMD's latest Ryzen 7 1700X processors, the Pyro Ryzen DG delivers eight cores and a total of sixteen threads – double what you'll get from a comparable Intel Core-i7 PC. It also comes with a powerful Nvidia GeForce GTX 1080 graphics card,

Design

The first thing you'll notice about the Wired2Fire is its eye-catching black and orange NZXT H440 mid-tower system case. If you can't get past the orange, there's a variety of other equally eye-catching options available, included a sober all-black version for the less flamboyant among us.

Key features of the NZXT H440 include a total absence of support for optical drives (remember those?), excellent cable management and a separate lower compartment for the power supply and hard drives, which keeps the main compartment extremely neat and tidy – perfect for viewing through the transparent side panel.

Filling the case is an Asus ROG CrossHair VI Hero motherboard. There's no cut-price B350 chipset to be seen here. Instead, we get one of Asus's premium models with all the bells and whistles of

AMD's advanced X370 chipset. These include extra USB 3.1 ports, improved overclocking headroom and, in this case, Aura Sync RGB LED lighting control. Perhaps more importantly, it includes multi-GPU support for both AMD CrossFireX and Nvidia SLI technologies, providing an easy upgrade path by adding a second graphics card at a later date.

But for now you'll be getting get a single Nvidia GTX 1080 which offers plenty of performance for high quality gaming at high resolutions and immersive VR experiences.

Wired2Fire has selected AMD's Ryzen 7 1700X eight-core processor for this PC, which is found here running at up to 3.7GHz. A Cooler Master Liquid 240 cooler is fitted with it's huge 240mm radiator fixed to the top of the system case.

Three 120mm fans are concealed behind the blank front panel of the case, protected by a removable dust filter, as is the power supply fan below. A 140mm exhaust fan is installed at the rear keeping the PC cool without excessive noise.

The Pyro Ryzen DG combines super-fast solid-state storage with the capacity of a 2TB traditional hard drive. A 250GB Samsung 960

Evo NVMe drive holds the operating system and as many games as you can fit on it, to deliver extremely fast loading times and generally snappier performance on the desktop.

Performance

While the 1700X turns in some impressive results in synthetic benchmarks, the problem for Ryzen-based systems such as this one is that, at the moment, most games can't take full advantage of those eight processor cores, favouring faster individual core speeds instead. If you're into processing 3D graphics or bulk editing photos, then you will love the speed of the Wired2Fire Pyro Ryzen, which can wipe the smile off the face of any Intel Core i7-7700K user when it comes to multi-core tests like Cinebench R15 where the Ryzen chip is more than 50 percent faster.

However, this doesn't translate into similar improvements in those all important gaming frame rates. Of course, gaming performance at decent resolutions is dominated by the graphics card, but the Wired2Fire Pyro Ryzen comes in a hair behind a similarly specified Intel-based PC in most of our benchmark tests.

The GeForce GTX 1080 delivers excellent frame rates, with 4K gaming possible at around 60fps in high quality settings

Thankfully, the GeForce GTX 1080 delivers excellent frame rates for your money, with 4K gaming possible at around 60fps in High and even Ultra quality settings in some cases, although tough modern games like Deus Ex: Mankind Divided are still going to knock you back to 30fps for UltraHD play. If you're gaming on a single PC monitor though, this is likely to be all the performance you'll need up to 2560x1440 pixels.

That's not to say the Pyro Ryzen DG is slow, far from it, but don't expect Ryzen to give you a better gaming experience than a high end quad-core Intel setup for now.

The Pyro Ryzen DG also delivers extremely fast storage, in the form of a 250GB Samsung 960 EVO NVMe SSD. These Samsung drives are dominating PC storage performance right now with speeds far in excess of SATA drives.

Warranty

Wired2Fire's three-year warranty looks good at first glance, but note that any faulty PCs must be returned at the customer's expense and parts are only covered for the first two years.

Verdict

This eye-catching PC is constructed from premium components and built to a very high standard. The eight-core Ryzen 7 1700X processor delivers excellent multi-threaded performance and, combined with a GTX 1080, turns in some very impressive gaming results, however similar or better performance can be had for less money.

YOYOTECH BLACKBOX SP

£1,649 inc VAT • yoyo.co.uk

Build	★★★★½
Features	★★★★½
Performance	★★★★☆
Value	★★★★☆
Overall	★★★★½

Finished in dazzling white with bright metallic purple accents, YoyoTech's Intel-based gaming PC certainly looks spectacular, but under that rather daring paint job we find a selection of well-chosen components pushed to the limit in the pursuit of the highest possible gaming performance.

Design

Whether your initial response to the appearance of the BlackBox SP is one of delight or horror, you can't dispute the elegance and space efficiency of the NZXT S340 compact mid-tower case – which is also available in a selection of other colours, including black – boring.

The NZXT doesn't pander to the needs of legacy component like optical drives, for which no space at all has been made

available. Instead, the entire front of the PC is a blank, minimalist panel of white, directly behind which sits the massive Kraken X52 High-performance 240mm liquid cooler that adds yet more razzle-dazzle to the PC's already rave-like appearance with its own customisable RGB lighting effects.

And the party doesn't stop there: the supplied Gigabyte AORUS Z270X GAMING 7 motherboard also comes with a built-in multi-zone LED light show and even the twin DDR4 3200MHz RAM modules self-illuminate like a pair of colour-changing glow sticks. This gaming-centric board offer massive upgrade potential with support for up to three-way graphics card options and triple NVMe PCIe SSDs in RAID 0 if you really want to push performance to the extreme.

Of course, you also get comprehensive automatic and manual overclocking with smart fan controls built in. Enhanced 'Killer' network performance and Creative Sound Core3D enhancements are also built in, along with plenty of USB 3.1 Gen 2 connectors and a Thunderbird port for high speed connectivity.

The YoyoTech BlackBox SP is most certainly a PC that's screaming out for attention, although, thankfully, all of these multicoloured lighting systems come with software controls, so you can easily turn them all off when no-one is looking and you really need to concentrate on your tax return.

The front of the PC is a blank panel, directly behind which sits the massive Kraken X52 High-performance 240mm liquid cooler

You'll be pleased to know that the BlackBox SP also has the performance to back up all of this multicoloured customisation. YoyoTech has chosen a 3.8GHz Intel Core i5-7600K quad-core processor, which has been overclocked to 4.6GHz. This approach CPU sacrifices the Hyper Threading of the more expensive Core i7-7700K, which doesn't give you useful performance gains for gaming, but gives you some extra MHz for free which saves you money that can be more usefully spent elsewhere in the system.

Another great component choice here is the graphics card. YoyoTech has selected an Nvidia GeForce GTX 1070 for this system. Of course, it's not just any GTX 1070: in keeping with the overclocked theme of the BlackBox SP, the PC comes with an EVGA GeForce GTX 1070 FTW Gaming, card which has been re-engineered from Nvidia's original spec to allow increased base and boost clock speeds up from 1506/1683MHz to 1607/1797MHz out of the box. It also comes with optional automatic overclock tuning and the enhanced cooling power capacity to allow it. Furthermore, it also lights up in user-configurable RGB colours – perfect for the BlackBox SP.

Some non-illuminated components are also installed, including a 250GB Samsung 960 Evo NVMe SSD, plugged directly into the motherboard and a separate 2TB magnetic drive tucked away into its own compartment, while a 750W EVGA Gold 80 Plus PSU supplies ample power for the system.
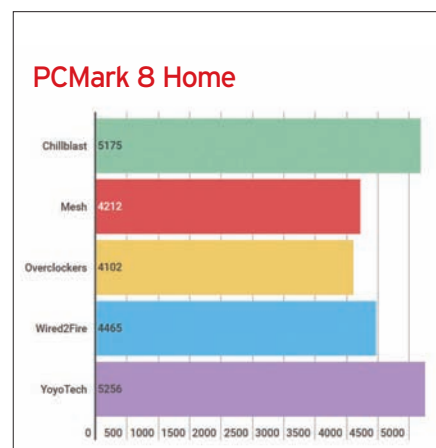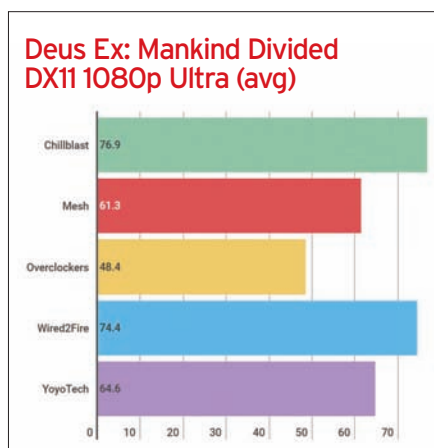
Performance

Overclocked PCs generally give very good performance for the money, and the YoyoTech is no exception. You can expect to crank the quality settings right up at resolutions up to 2560x1440 without dipping below 60fps on many titles, and similar performance can be achieved at 4K with reduced quality settings, although the highest resolutions are a little more challenging for this GTX 1070 than a stock GTX 1080, despite its overclocked performance tweaks. It'll also breeze through VR titles, if that's your bag.

Outside of gaming, the YoyoTech BlackBox SP continues to perform well, convincingly outpacing Ryzen 7-based systems and coming in just a little behind the more expensive Core i7-7700K for most tasks. A Core i7 will pull ahead in intensively multitasking scenarios like the Cinebench R15 multiple CPU test, but this is of no real advantage to gamers who will be served very well by the BlackBox SP's overclocked Core i5.

Verdict

If you love bright, pulsing lights with customisable colours, then the YoyoTech BlackBox SP has got your name written all over it. If you love high-performance gaming, you'll also enjoy the overclocked Intel CPU, Nvidia graphics and NVMe storage, which combine to deliver superb performance for your money.

> **You can expect to crank the quality settings right up at resolutions up to 2560x1440 without dipping below 60fps on many titles**

Cinebench Multi-thread

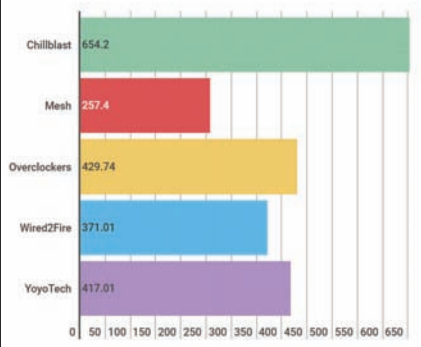|	
Chillblast	959.05
Mesh	1524.51
Overclockers	1646.02
Wired2Fire	1523.58
YoyoTech	736.4

Deus Ex: Mankind Divided DX11 1080p Ultra (avg)

Chillblast	76.9
Mesh	61.3
Overclockers	48.4
Wired2Fire	74.4
YoyoTech	64.6

PCMark 8 Home

Chillblast	5175
Mesh	4212
Overclockers	4102
Wired2Fire	4465
YoyoTech	5256
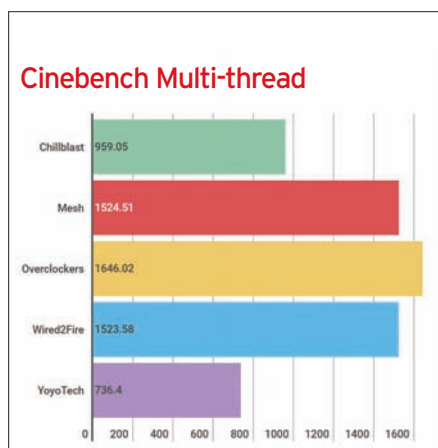
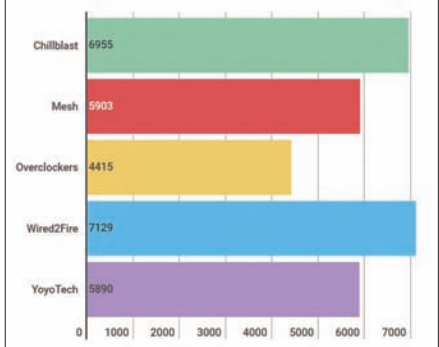|	CHILLBLAST £1,549 (inc VAT & delivery) ★★★★⯨	MESH £1,600 (inc VAT & delivery) ★★★★☆	
Product name	Fusion Adamantium 3	Ryzen 7 Gaming PC-A	
Processor	Intel Core i7 7700K 4.2GHz (4.5GHz OC)	Ryzen 7 1700X	
CPU Cooler	Chillblast Centurion CPU Cooler	Corsair H60 Hydro Series	
Installed memory	16GB DDR4 2133MHz	16GB 2400MHz DDR4	
Storage	250GB Samsung SM961 M.2	250GB WD Blue M.2 SATA SSD	
Power supply	600W Aerocool PSU	650W Corsair RM650x	
Motherboard	Asus Z270M-PLUS motherboard	Asus AMD AM4 Ryzen PRIME X370 Pro	
Operating system	Windows 10 Home (64-bit)	Windows 10 Pro (64-bit)	
Display	None	None	
Graphics card	Nvidia GeForce GTX 1080 8GB	Nvidia GeForce GTX 1070	
Sound card	On-board	On-board	
Networking	Gigabit ethernet	Gigabit ethernet	
External USB ports	3x USB 3.0, 6x USB 2.0	2x USB 3.1 Type-A, 1x USB 3.1 Type-C, 5x USB 3.0, 2x USB 2.0	
Other ports	2x PS/2, DP, DVI, HDMI	Mic, headphone, PS/2 combo port	
Optical drive	None	None	
Case	Chillblast Kube Case (Black/Blue)	Thermaltake View 31 RGB TG Mid-Tower	
Keyboard & mouse	N/A	None	
Extra items	N/A	None	
Warranty	2 years collect and return, 5 years labour only, lifetime phone	Lifetime labour, 2 years parts, 1-year free collect and return	

Power consumption (load)

Chillblast	394
Mesh	318
Overclockers	389
Wired2Fire	358
YoyoTech	357

Storage bandwidth (MB/s)

Chillblast	654.2
Mesh	257.4
Overclockers	429.74
Wired2Fire	371.01
YoyoTech	417.01

3DMark TimeSpy

Chillblast	6955
Mesh	5903
Overclockers	4415
Wired2Fire	7129
YoyoTech	5890
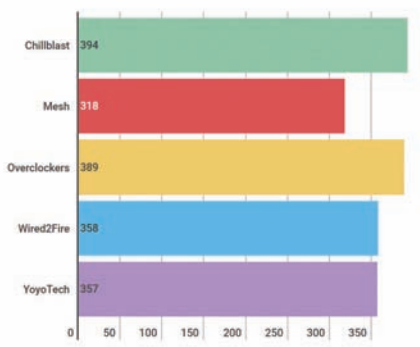
OVERCLOCKERS UK £1,260 (inc VAT & delivery) ★★★★½	WIRED2FIRE £1,675 (inc VAT & delivery+24) ★★★★½	YOYOTECH £1,649 (inc VAT & delivery) ★★★★½
Titan Falcon	Pyro Ryzen DG	BlackBox SP
AMD Ryzen 7 1700 (3.8GHz OC)	Ryzen 7 Eight Core 1700X 3.4GHz (3.7GHz OC)	3.8GHz Intel Core i5-7600K (4.6GHz OC)
Alpenfohn Ben Nevis CPU Cooler – 120mm	Cooler Master – Master Liquid 240	NZXT Kraken X52 240mm Variable Speed Liquid Cooler – RL-KRX52-01
Corsair 16GB (2x 8GB) DDR4 2400MHz Dual Channel Kit	116GB DDR4 2400MHz	16GB (2x 8GB) DDR4 3200MHz G-Skill Trident Z RGB
Samsung SM961 Polaris 256GB M.2-2280, Seagate BarraCuda 2TB 7200rpm SATA 6Gb/s 64MB Cache HDD	250GB Samsung 960 Evo SSD and 2TB Barracuda	250GB Samsung 960 Evo NVMe M.2 SSD, 2TB 7200rpm Toshiba HDD
Cougar VTX 650W (Bronze 80 Plus power supply)	FFSP 750W PSU (Silver 80 Plus power supply)	750W EVGA (Gold 80 Plus power supply)
Asus Prime B350-Plus AMD B350 (Socket AM4) DDR4 ATX motherboard	Asus ROG CrossHair VI Hero motherboard	Gigabyte AORUS Z270X GAMING 7
Windows 10 Home (64-bit)	Windows 10 Home (64-bit)	Windows 10 Home (64-bit)
None	None	N/A
Sapphire Radeon RX 480 Nitro+ OC 8192MB GDDR5 PCI-Express Graphics Card	nVidia GeForce GTX 1080 8GB GDDR5X Graphics Card	EVGA GTX 1070 FTW ACX 3.0 – 08G-P4-6276-KR
Onboard	Onboard	Onboard
Gigabit ethernet	Intel I211-AT, 1x Gigabit LAN Controller(s)	1x Intel GbE LAN chip (LAN1), 1x Killer E2500 LAN chip (LAN2)
2 x USB 3.1, 2 x USB 3.0/2.0, 6 x USB 2.0/1.1	Rear: 1x 3.1 Type-A, 1x Type-C, 8x USB 3.0, 4x USB 2.0 Front: 2x USB 3.0, 2x USB 2.0	1 x Thunderbolt 3, 1 x USB 3.1 Gen 2 Type-A, 5x USB 3.1 Gen 1
2x HDMI, 2x DisplayPort, 1x DVI	Optical	1x DVI, 1x HDMI, 3x DP
None	None	None
Cooler Master MasterBox 5 Midi Tower Case (Black)	NZXT H440	NZXT S340 (Matte White/Purple)
N/A	None	N/A
N/A	None	N/A
3-year collect, return and labour	3-year return to base (3 years labour + 2 years parts)	3-year return to base (2nd and 3rd years labour only)

Conclusion

AMD's latest Ryzen processors offer a worthy challenge to Intel's high-end enthusiast socket 2011 v3 processors, but when it comes to gaming a decent Intel quad core system is still currently the configuration of choice.

Of course, this may change as software and drivers are optimised to take better advantage of Ryzen's multiple cores.

An Intel Core i7-7700K processor such as the one found in Chillblast's Fusion Adamantium 3 is still the one to beat when it comes to the ultimate gaming processor, although stepping down to the Core i5-7600K can be very cost effective, especially when overclocking is employed as in YoyoTech's BlackBox SP. Both of these systems come highly recommended.

From the Ryzen camp, Overclockers UK have built a formidable system in the form of the Titan Falcon, which makes efficient use of less expensive components through overclocking, so deliver an excellent value for money proposition – just configure it with a more powerful graphics card if you want to match the frame rates of the Nvidia-based challengers in this group test. It also comes with that superb three-year warranty.

Wired2Fire's Pyro Ryzen DG cuts no corners in its selection of premium component and performs very well, but is a little pricey, while Mesh's Ryzen 7 Gaming PC-A is probably the best looking system for the bunch, but is let down by its slower SATA SSD and choice of operating system.

How we test

To test general PC performance, we're use Futuremark's PCMark 8 v2.0 benchmarking suite. Unlike the previous PCMark 7 benchmark, the new version doesn't produce a single overall figure. Instead, results are divided into Home, Creative, Work and Storage tests. The Home benchmark reflects common tasks for typical home use with lower computing requirements, such as web browsing, photo editing and low-end gaming.

The Creative benchmark is aimed more at enthusiasts and professionals working with multimedia and entertainment content. It is more demanding on the processor and includes transcoding tests as well as further gaming workloads.

The Work test is geared towards office work tasks such as creating documents, web browsing, spreadsheets and video conferencing. It does not stress the gaming and multimedia capabilities of the PCs.

Gaming performance

We've used three games to evaluate graphics performance. We run our tests at 1280x720, 1920x1080, 2560x1440 and 3840x2160 pixels at various quality settings appropriate to the performance level of the PCs or graphics cards being tested.

Our current benchmark games are Thief, Alien Isolation and Deus Ex Mankind Divided. Most resolutions are tested in both High and Ultra present modes with low resolution 720p tests occasionally conducted in low quality modes on low-end devices which would otherwise struggle with gaming. We make no other tweaks to the game settings, so if you want to run these tests for yourself, you can just pick from the presets named in our individual test results.

We also run Futuremark's 3DMark suite of benchmarks to help evaluate gaming performance in eight different usage scenarios. With these results, we can get a good idea of the level of quality and display resolutions a given PC can run acceptably. In this group test, the scores are all very close, due to the similar hardware used. Results are given in points and higher numbers are better.

VRMark – also from Futuremark – stresses the PCs much further and provides an insight into how they might perform with more demanding Virtual Reality titles in the future.

It consists of two benchmark tests: the 'Orange Room' test which will verify that your PC meets the minimum performance requirements for HTC Vive and Oculus Rift and a more demanding 'Blue Room' test, which evaluates performance at the very highest settings and is much trickier for current PC hardware to pass (we've not yet seen one pass the test).

To meet the bare minimum specification for Oculus Rift, a PC must score at least 3,716 points in the Orange Room, while a PC Futuremark considers to be VR-ready must score over 5,000. In the Blue Room, corresponding scores are much lower at 719 points and 1082 points respectively.

Power consumption torture testing

We measure the power consumption of each PC base unit when idle, and again while running at its performance limit. During the idle test, the PCs hard drives are still spinning and the power-management features are not enabled. For the full-load torture test, we run Prime 95 to force all CPU processing threads to maximum utilisation and stress system memory.

At the same time we run the Geeks3D Furmark benchmark to stress any installed graphics cards. We leave these tests running for 10 minutes, then record the power consumption and the maximum CPU core temperature reached.

Power consumption will increase with performance, and overclocking will require significantly more power. Greater power usage also required better cooling, and these test allow us to verify that the installed cooling systems are up to the task of keeping temperatures within safe limits.

Overclocking

Because gamers demand the best performance from their hardware, we allow vendors to overclock PCs in this category. We require that the PC vendor offers a comprehensive warranty covering the overclocked system. Be aware that if you overclock the PC yourself, you may invalidate your warranty.

Subjective assessment

We pay close attention to the physical characteristics of each PC, its noise output and its build quality, delving inside the case and taking note of the quality of components used, cabling and airflow.

Support

Differences in warranty terms can impact our scoring. Long warranties are sought after, but we also look at the terms and conditions – specifically, whether faulty PCs must be returned to the vendor at your cost, and if both parts and labour are included. ⊠

10 powerful, obscure Windows shortcuts you should know

Ian Paul's Windows keyboard shortcuts will take you beyond the basics and speed up your workflow

We're big fans of keyboard shortcuts. Memorising key combinations takes some work, but once you have, shortcuts make using an operating system so much more efficient.

Many people know the everyday keyboard shortcuts, such as how to copy, cut and paste text with the keyboard, how to close a window and how to lock a computer.

That's a solid start, but there are even more powerful shortcuts lurking beyond the basics. Here are some of our favourite less commonly used shortcuts. We've grouped these by operating system to make it easier for users of Windows 7, 8.1 and 10 to see what's available for their system.
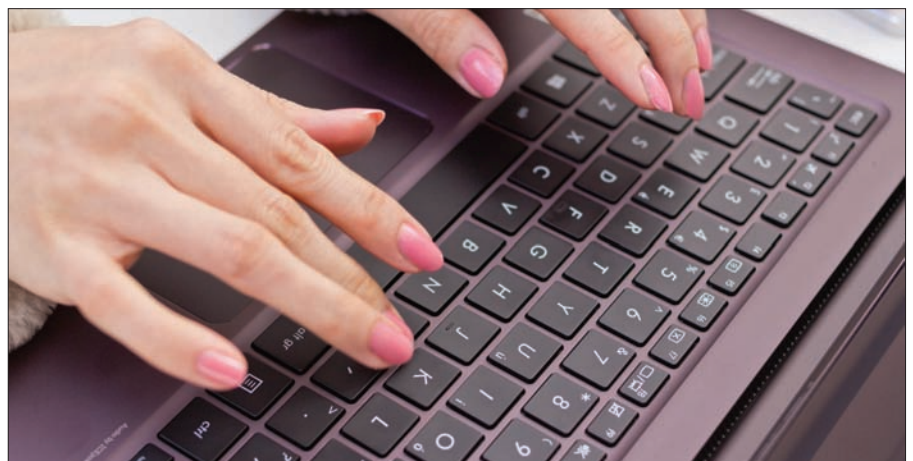
Windows 7 and up

F2: Prepare selected file for renaming – no more careful clicking.

Alt + Enter: Select a file and then use this shortcut to display its properties.

Windows Key + M: Minimise all windows to the taskbar (Windows Key + Shift + M restores them).

Windows Key + Home: Minimise everything but the active window.

Windows Key + Pause: Display the system properties dialog box.

Windows key + Shift + right or left arrow: Move the active window to the next monitor in the direction indicated.

Ctrl + Y: Redo an action.

Windows 8.1 and up

Windows Key + comma key: Peek at the desktop.

Windows 10 only

Windows key + Alt + D: Display the time and calendar panel (equivalent of clicking the time on the taskbar).

Windows key + Tab: Open Task View. Remember this? It's how you create virtual desktops in Windows 10. A handy feature for people who like to multitask. ⊠

> Many people know the everyday keyboard shortcuts, such as how to copy, cut and paste text with the keyboard… but there are even more powerful shortcuts lurking beyond the basics

How to build a Linux home server on the cheap

Alex Campbell reveals how your options range from free to a few hundred pounds

Ask any Linux enthusiast, and they'll tell you how fantastic an operating system Linux can be. For the desktop user, the freedom from worry about most viruses is a big plus, and not spending £100 upgrading Windows is a big plus too. As great as Linux is for desktop use, it truly shines as a server. While providing web-based services is one of those server-type options Linux does really well, the OS can do a lot more than host a blog about family outings.

If you're looking to host your own services instead of paying for or relying on those in the cloud, running your own home server is a great way to keep your files private.

Choosing software

Choosing the specific Linux distribution for your home server can be daunting since there are so many strains to choose from. Most of the time, we just uses Ubuntu and recommend that first-time users do the same. The reason is simple: Ubuntu Server is easy to administer, well documented, and has a pretty low learning curve.

The next big thing you'll have to worry about is what programs to run on the server. There is a huge amount of free and open-source software you can host yourself, but finding it can be tricky. Luckily, a GitHub user named Edward D. maintains a list of self-hosted software at tinyurl.com/nf9qfbr that you can run on a Linux server. The list has everything from blog software to

If you're looking to host your own services instead of paying for or relying on those in the cloud, running your own home server is a great way to keep your files private
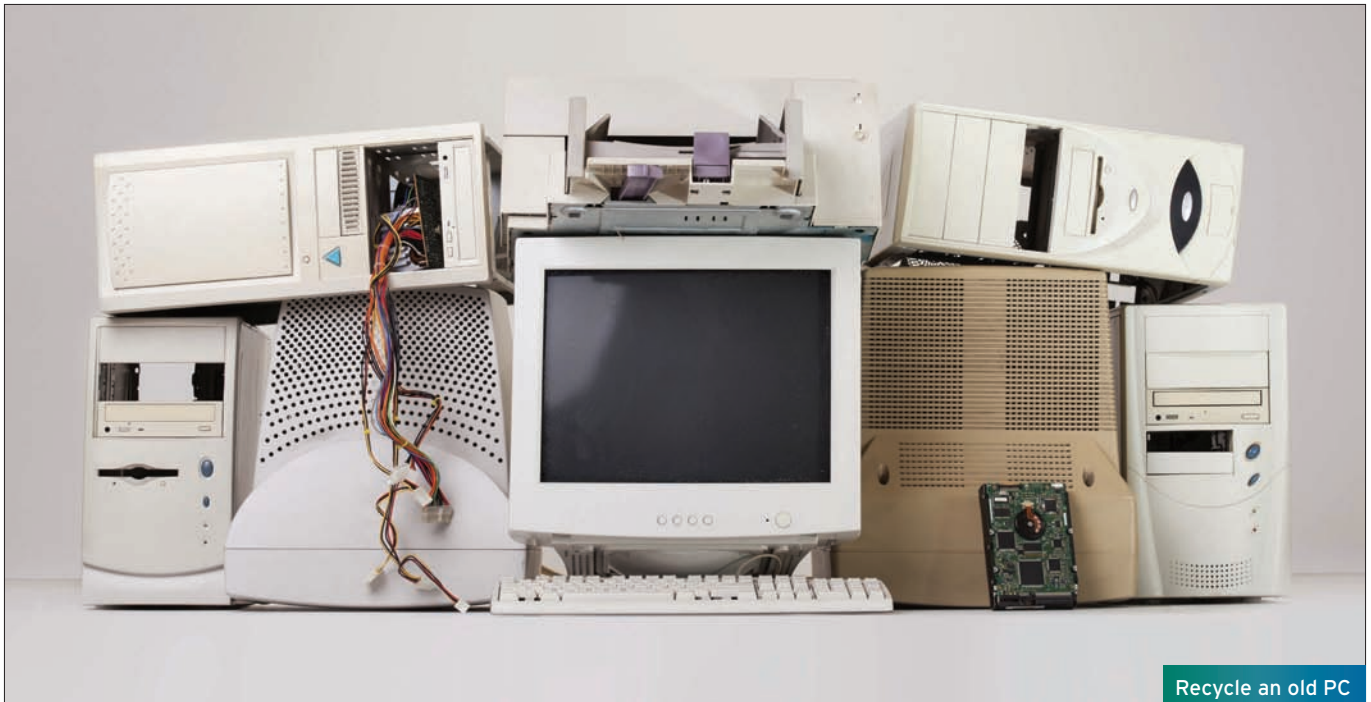
Recycle an old PC

CRM. It even features some awesome meta packages (which let you bulk-install a group of applications) like sovereign.

Indeed, sovereign is a good starting point for users who are looking to be digitally self-reliant. With a couple commands, sovereign will install an email server, a VPN service, nightly backups, a CalDAV and CardDAV server, and ownCloud, just to name a few.

Once you have an idea of what you want to host on your server, the next step is choosing the right hardware.

Choosing hardware

One of the most common ways to use Linux in a home server is to install the operating system on an old desktop.

The hardware requirements for Windows have marched forward as time and versions have progressed. While you might technically get Windows 10 to run on a PC that's been sitting in the garage for five years, its performance might be less than ideal.

That old PC could be a nice host for Linux. On top of saving you some money, repurposing an old PC as a Linux server is good for the environment. Reusing the PC keeps e-waste out of landfills and stretches the life of the heavy metals and precious and/or toxic materials that comprise many PC parts.

Raspberry Pi 3: £30 and up

There's a reason people love the little Raspberry Pi. For £30 you get a palm-sized computer that has networking, USB ports and general-purpose pins to satisfy all of your tinkering needs. While the Pi is a great tinkerer's toy, it's also great as a low-power server.

It's powered via a Micro-USB connection and sips power compared to big desktop components. If you're looking for a server to host just a couple of services to a small number of users, the Pi is a wonderful platform to start with. It doesn't have any storage on-board, but if you plan on running a file or media server with it you can always buy or reuse an external USB hard drive or a large USB stick.
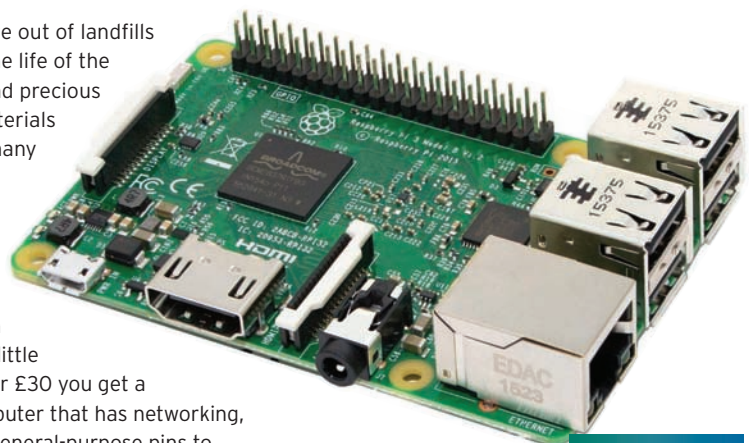
Raspberry Pi 3

NUCs and small PCs: £130 and up

Small PCs are often marketed as low-powered desktops or home-entertainment PCs, but they also make great servers. Intel's Next Unit of Computing (NUC) models (see image below) are well equipped for light- to medium-duty server use in a home.

Much more robust than their ARM-based Raspberry Pi counterparts, Intel's NUCs will consume more power but be able to handle more computationally intensive tasks. Some

Intel's NUC models can be used as home servers

NUC models will have room for a 2.5in SSD for onboard storage. Other models will force you to outsource bulk storage of big files to an external drive, not unlike the Pi.

If you prefer AMD to Intel, there are some other options as well, including Gigabyte's Brix, which offers many of the same features as the NUC.

Network attached storage (NAS) appliances: £83 and up

If you're worried you don't have the technical chops to install and maintain your own Linux server, you can always go for a network-attached storage (NAS) system. A NAS is basically a small Linux or BSD server with the primary function of hosting files. You can think of a NAS as your own extensible Google Drive or Dropbox.

Lots of companies offer NAS solutions in one form or another, but two of the big names are QNAP and Synology. Both companies offer many of the same features, but the web interfaces are different for each.

For small businesses that just need something to work, a medium-sized NAS can

Synology DS716+II

be a simple, plug-and-play solution. With a NAS, you generally don't have to fight with drivers or settings during setup; everything can be accomplished using an easy-to-follow web interface. While you can find diskless NAS devices for as little as £83, they will

come without any hard drives. Hard drives for NAS boxes tend to cost a little more than the typical desktop hard drive, since they are designed to be always-on, and to keep data safe for a long period of time. (See our best NAS drive chart on page 138.)

Virtual private server (VPS): £3.50 per month and up

Okay, so this isn't a way to have a Linux server in the home. A virtual private server is exactly what it sounds like: a virtual machine instance in a server farm. 'Private' refers to the fact that other VPS machines in the same server farm can't steal resources or interact with your VPS. In effect, it's like having your own little Linux box connected to a server farm somewhere.

VPS solutions can be great if you need to run a small blog or some other service that you'd rather not run from home. Unlike running a service on a home server, a VPS does not require you to open up ports on your router and fiddle with dynamic DNS.

Of the VPS providers out there, Digital Ocean offers some of the better deals for the individual or small business. Its servers start at £3.50 per month, and you can spin up more in seconds if you need them. Besides being a great way to learn how Linux works, running your own server at home can let you break away from commercial services and take back control of your data. ⊠

Besides being a great way to learn how Linux works, running your own server at home can allow you to break away from commercial services and take back control of your data
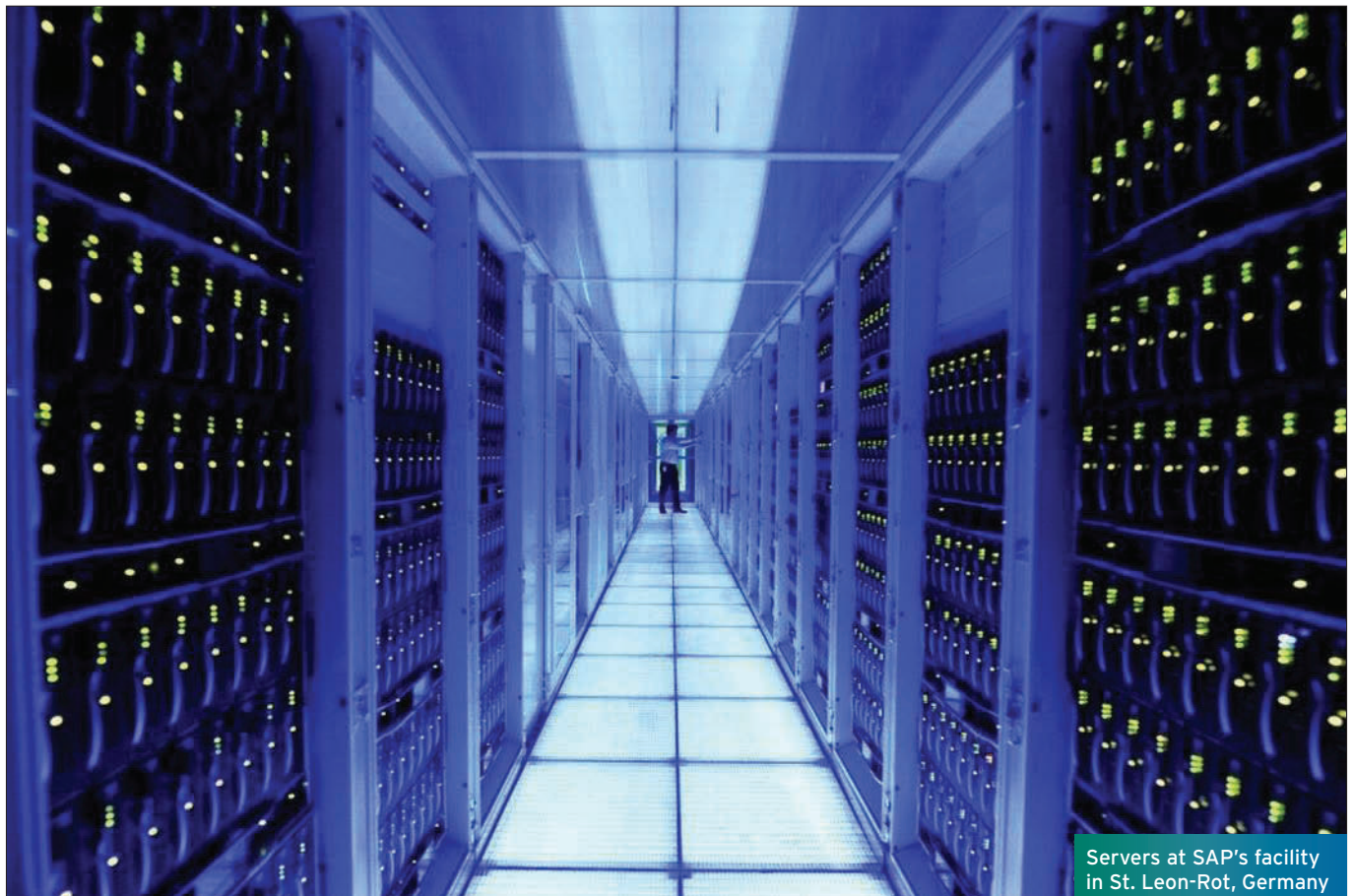
Servers at SAP's facility in St. Leon-Rot, Germany

RYZEN MYTHS:

Perception

VS

Reality

WITH AMD'S NEW CPU
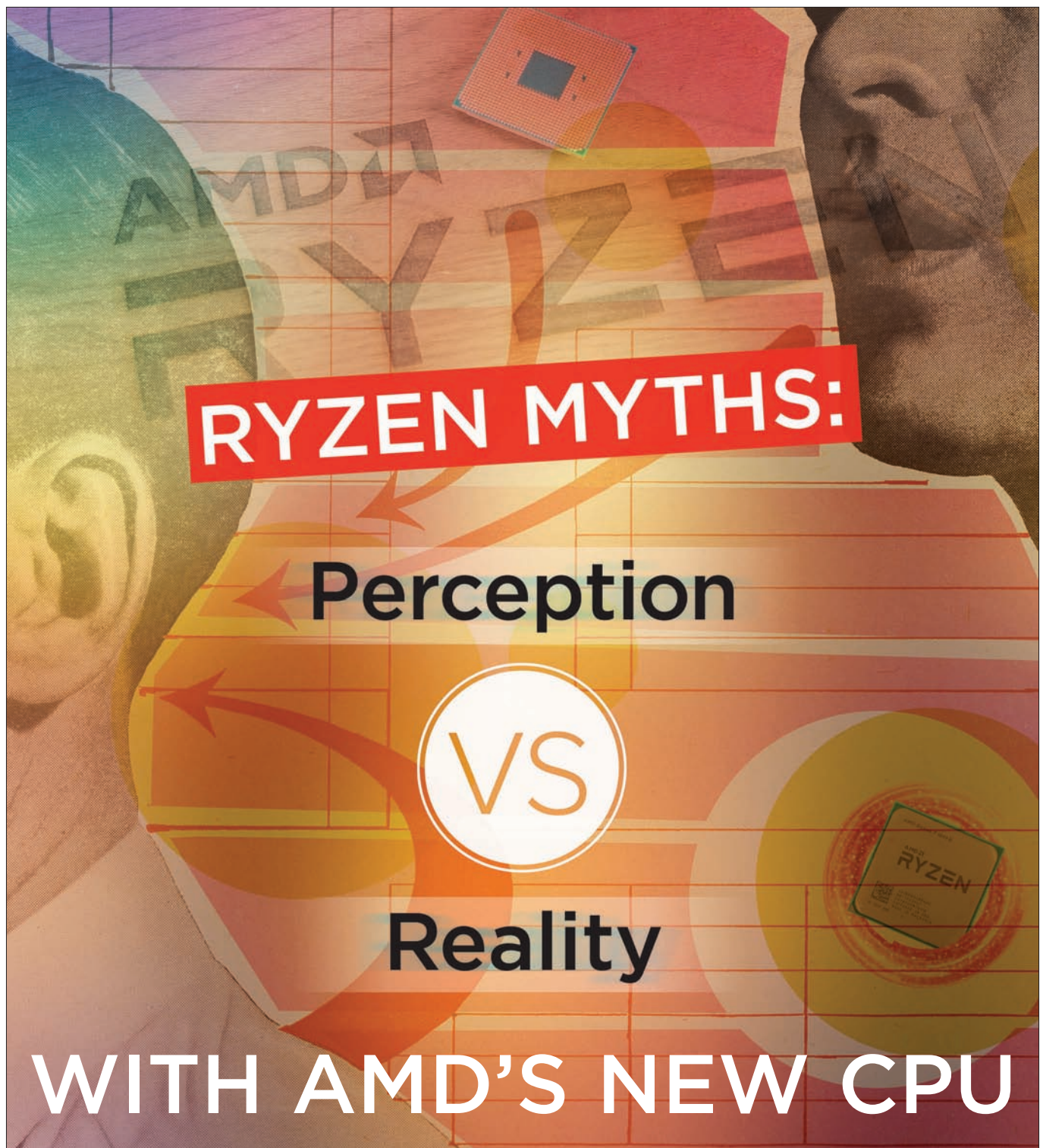
Gordon Mah Ung cuts through the chatter, myths and hearsay

With the Ryzen 7 launch just over two months ago and Ryzen 5 now here, AMD's comeback CPUs are generating as much controversy, confusion, and misinformation as they are excitement. Here we cut through the chatter to give you the real answers about AMD's latest CPU.

PERCEPTION: Ryzen runs hot
REALITY: Not true

Despite really low thermal design power (TDP) ratings, Ryzen chips have oddly been labelled as running hot. The problem seems to relate to how utilities are reading the new chips' on-die sensors. AMD, in fact, just disclosed that certain

CPUs feature offsets that make it look as though they are running hot.

"In the short term, users of the AMD Ryzen 1700X and 1800X can simply subtract 20°C to determine the true junction temperature of their processor. No arithmetic is required for the Ryzen 7 1700. Long term, we expect temperature monitoring software to better

understand our tCTL offsets to report the junction temperature automatically," the company wrote in a blog post.

Keep in mind, we're talking about Ryzen performance under stock settings – not overclocked. Even so, if the tool were off by 20°C in the upward direction, it would definitely appear to be hot. The fix is likely to come once the utilities are updated to recognise the offset of the CPU.

**PERCEPTION:** Ryzen is terrible when it comes to gaming
REALITY: Not true

If there's just one fact from this entire feature that you should remember, it's this one: Ryzen is not terrible for gaming. Yes, even if your friend heard it from a friend who was watching a friend's Twitch stream, we repeat: it is not terrible for gaming.

AMD's gaming performance can at times be perplexing. In multi-threaded and single-threaded applications, it's generally outstanding. In tested games, however, Ryzen tends to takes third place behind Intel's Kaby Lake and Broadwell-E CPUs. This is akin to saying an Olympic 100m runner is 'slow' for getting a bronze medal. Of course, its gaming performance at higher resolutions and high-quality visual settings is mostly imperceptible, because that usually turns into a GPU load, rather than a CPU load. In sum, Ryzen is a fine gaming CPU and not terrible at all.

PERCEPTION: AMD is as good as Intel in gaming today
REALITY: Partially true
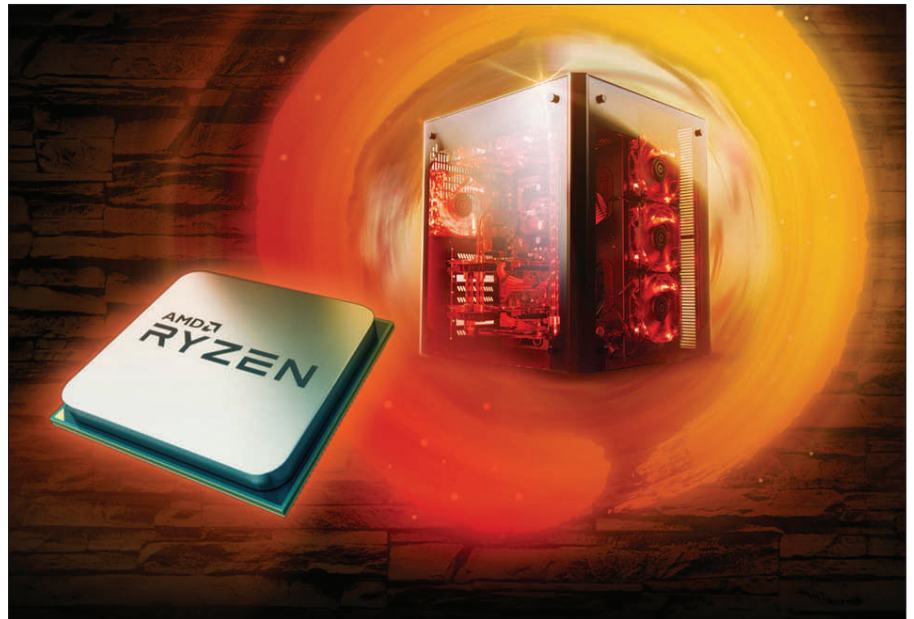
We've said that Ryzen isn't terrible for gaming, but it's also not the best. The vast majority of our own tests, along with those conducted by other reviewers, show that when using today's games and today's version of Windows, Ryzen takes a back seat to Intel's CPUs.

This can be seen at the most popular resolution of 1080p and lower, and even at higher-quality settings in some games. The processor will also likely falter with monitors that push high refresh rates, such as 120- or 144Hz. As much as some fans may not want to accept it, the chip isn't as good as Core i7 in many gaming scenarios.

Ryzen will be as good as Intel, however, when you run that game at 4K Ultra HD resolution. At higher resolutions – which is where you should be playing with a beefy GPU such as a GTX 1080 or GTX 1080 Ti – the graphics card becomes the bottleneck, and you'll notice little or no difference between a Ryzen or Core i7.

Ryzen has proved itself equal to or better to Intel Core i7 in some games. However, reasonable observers would agree that Intel has the lead given today's conditions. Tomorrow there may be optimisations, but tomorrow is not today, and the frame rate today is what gamers care about.

Despite what you may have heard, Ryzen is not terrible for gaming at all

The other possible advantage Ryzen may have over Intel's quad-core gaming chips is in game hitching. Anecdotal reports have suggested some games on Ryzen will see fewer hitches than they'd experience with a quad-core CPU, due to the additional cores on the AMD chip.

PERCEPTION: An eight-core chip is a better gaming CPU if you want to be the next YouTube sensation
REALITY: True

Reasonable people will agree that Intel's parts are faster than AMD's chips for today's games, but that's for traditional gaming. The exhibitionist culture of today means you don't play by yourself anymore – you're probably streaming live to an audience on YouTube, Twitch or Facebook as you try to become the next internet sensation.

Reasonable people will agree that having more cores for real-time game streaming means having an eight-core CPU is better. That's because most streaming software uses the CPU to encode the stream, which eats up resources. A quad-core processor will run out of resources before an eight-core chip does, leading to dropped frames and hitching.

This isn't even a partisan divide. Sure, AMD has pushed more cores as an advantage of its Ryzen over Intel's Kaby Lake, and Intel has used the same argument for pushing its six- and eight-core Core i7 chips over its own quad-core chips.

There's an argument that using GPU encoding, such as GeForce Experience's ShadowPlay, works just as well. This is true, but most streamers are very much the definition of content creators and will use video editors daily.

In the end, if you do want to be the next YouTube or Twitch sensation, an eight-core chip is the better choice.

PERCEPTION: It's Windows 10's fault
REALITY: Not true

As people tried to get to the bottom of why Ryzen performed so well in applications (both multi-and single-threaded) but not on games, the usual suspect was called in for questioning: Windows. Many theorised that its scheduler, or the part of the OS that doles out workloads to the CPU, just wasn't playing nicely with Ryzen. In the end, AMD itself cleared Microsoft as a suspect, saying the scheduler is functioning correctly.

We reached out to Microsoft to confirm whether it was indeed working on correcting issues with the scheduler on Ryzen, but at the time of writing had not heard back.

If AMD itself is saying Windows 10 isn't at fault, that pretty much settles it. Considering that Linux kernel needed a patch to account for Ryzen's multi-threading, how did Windows 10 skate through? It's not like a vendor would be ordered to fall on its own sword to protect Windows 10's reputation, right?

PERCEPTION: Reviewers who wrote negative things about Ryzen are shills for Intel
REALITY: Not true (mostly)

It's almost impossible to fact check for shills, because many influences on reviewers are unseen and impossible to prove. What we can say is that many of those accused of being biased towards Intel are also among those AMD itself cited in the coverage of the new Ryzen chip.

If that were the case, why would AMD point to their coverage as proof of the success of Ryzen? Many of the reviewers of the processor have also continued to follow initial coverage with additional testing, in an attempt to get to the bottom of why Ryzen isn't quite as fast as Intel in gaming.

Short of accessing the bank accounts of all supposed shills, we can chalk up the accusations to the pent-up enthusiasm of a dedicated fan base.

PERCEPTION: There's a massive shortage of motherboards
REALITY: Mostly true

After an initial shortage of Ryzen CPUs, they are now readily available. The problem is that you may not be able to get a motherboard to put it in.

Specifically, it's hard to find the top-end, enthusiast-focused X370 boards. Plenty of the more sedate B350 boards are available.

No need to throw in the towel, though. Spot checks on Amazon (at the time of writing) showed some availability. One motherboard vendor promised that more were arriving by the boatload.

Still, we'll rate this as mostly true, because when you have a shiny new Ryzen 1700 staring at you from your build bench, you're not going to be a patient camper. ⊠

When the PC community wants to blame someone, Windows is always among the usual suspects

BEST
PHOTOGRAPHY
techniques

Whether you're using a phone, a camera or a drone, Mark Pickavance's tips will help you take better photos

Unlike the film photography era, it doesn't cost anything to take pictures, unless you count the price of your phone or DSLR. Not having to worry about how many shots you're taking is a major advantage, because it allows for experimentation. The more of this you do, the greater understanding you'll have of what your device can do, how the controls work, and how to get the best out of what technology is to hand.

Most of our tips cost little or nothing, so you've no excuse for not trying them out. While our advice is primarily aimed at those with a digital SLR camera, many of the tips apply equally to any camera, including those on smartphones. Plus, phone cameras are getting surprisingly good these days.

1. Aperture priority

The aperture priority is enabled by using 'A' or 'Av' mode on most DSLR camera dials. Selecting this mode will empower the DSLR to decide ISO and shutter speed, while leaving aperture as the single feature that's not camera controlled.

The function of the aperture is to control the amount of light entering the sensor, and control depth of field. Doing this allows you to blur out the background and drive the focus entirely where the images are sharpest.

A high aperture setting or f/1.4 or f2.0 (which lets in a lot of light) will give a very narrow depth of field, where a low one such as f/22 (which is a tiny hole that lets in much less light) will make a deep one with much of the scene in focus. The more expensive lenses offer high aperture settings, allowing for more overall focus control.

for example, is best done at a slower shutter, tracking the car to create motion blur around it, while leaving the vehicle sharp.

Conversely, any sport with water is often best shot at the very highest possible speed, capturing all the liquid surface details.

What you can't ignore is what the camera does with the aperture. With a high f/22 setting the background will be as detailed as the foreground competitor/ vehicle, unhelpfully.

Those wanting to shoot sports on a regular basis will need a big 400mm (or longer) lens, a supporting monopod, and be happy to sift through many hundreds of images that never quite caught the moment.

3. Long exposures

Using long exposure times, you can capture the movement of stars, cars on the road at night and the airliners on their final approach. The trick is balancing the light entering the lens with the length of exposure. The timing requires a bit of guesswork because the light metering in most DSLRs just doesn't work well for multi-second or minute long exposures.

The mode you need to use is called 'Bulb', and it allows you to hold the shutter open for as long as is necessary.

Depending what you're trying to capture, that might be a few seconds or hours.

Here's a photo shot with a high aperture

When using aperture priority keep an eye on the shutter speed, because should it get below 1/30 second, it will become difficult to shoot handheld and avoid blurry photos.

2. Sporting shots

Unless you're photographing Crown Green Bowls, the speed of those taking part becomes a critical factor in how you approach getting decent sports photographs.

Ideally, you usually want to freeze the subject in action, requiring a high shutter speed in preference to aperture control.

Using shutter priority mode is the obvious choice, usually the 'S' setting on the mode dial. The beauty of shutter priority is that you can set 1/500 of a second, and know that you'll get precisely that.

However, a high shutter speed doesn't suit all sports. Photographing racing cars,

Capturing the moment

Image taken using a long exposure

To avoid movement of the camera, you'll also need a sturdy tripod and a release cable to operate the shutter.

It's worth noting that some traditional long exposure effects, like star trails, are often easier to achieve by taking multiple short exposure sequential shots and combining them in post-production.

4. The Thirds rule

This notion might seem highly unscientific, but humans like the composition of things where objects and transitions happen at approximately one third from the sides of the image, vertically and horizontally.

Known as the 'rule of thirds', photography students are taught to place those things they'd like the viewer to focus on along these lines and the intersections between the horizontal and vertical lines.

To help in this most cameras will provide a grid, though oddly most DSLR cameras have a grid with quarters or 'fourths', not thirds. (Most smartphone camera apps also have a grid overlay which can be enabled.)

The answer for DSLRs is to buy an extra screen protector and mark it with your own 'thirds' lines, solving the problem for minimal outlay.

On some cameras, it is possible to replace the focusing screen element with one marked with thirds. But that isn't an exercise for the faint-hearted, and these replacements cost much more than a plastic screen protector. Many images have symmetry where important elements seem to align with the rule of thirds, even if some people don't accept it's a thing.

5. Thirds on Photoshop

If you want to see a 'thirds' grid overlaying any image in Photoshop (see below), here's the procedure:

The rule of thirds

- Open Photoshop
- Press Ctrl-K (Alt-K on the Mac)
- Select 'Guides, Grid & Slices'
- Set Gridline Every to '100' and 'Percent'
- Set subdivisions to 3

Make sure that Grid is 'shown', and you'll see where the thirds are on any image.

6. How to shoot sunsets

Great sunset shots are about preparation, and not just being there when the sun goes down. But first, be safe. Always use 'live view' on the camera display and not direct or optical viewing, as you can damage your eyesight should the clouds suddenly part.

Those wanting to shoot the setting sun in detail will need at least a 200mm lens, and a tripod to avoid camera shake or high grain (ISO 800 or higher) images.

Those who want to capture a landscape at sunset have two basic options; accept a silhouette or use multiple combined exposures. In a silhouetted sky that region becomes the critical exposure concern. Unless you've got lots of water to reflect it. Alternatively, you can shoot bracketed exposures to bring out the detail and colour in the landscape lost on those frames where the sun and sky look amazing.

The best modes for sunset shots are either with an aperture or shutter priority. Pick one of these and then keep adjusting

that control while shooting a spread of different settings. Using exposure locking onto dark areas is often a good plan, and always shoot RAW files so you can reclaim lost detail where needed.

For each amazing sunset shot a photographer gets, there are usually hundreds that didn't quite work. It's mostly about perseverance.

7. Better sea shots

Photographing the ocean can be a challenge, mostly because so much of what you see in the water is reflected sky. If the sky isn't interesting, then the sea won't be either. One way to get an interesting seascape is to wait for an especially windy day, and one that has the odd break in the clouds is ideal.

Shooting at high shutter speed should pull some great detail out of the churning surf. But please be mindful of safety. Don't stand anywhere that could get your equipment might get wet or swept away.

8. How to photograph children

For obvious reasons, when photographing youngsters make sure that you have the permission of those responsible for them to do that. Great shots of them usually involve capturing those moments when

Using a 'thirds grid' in Photoshop
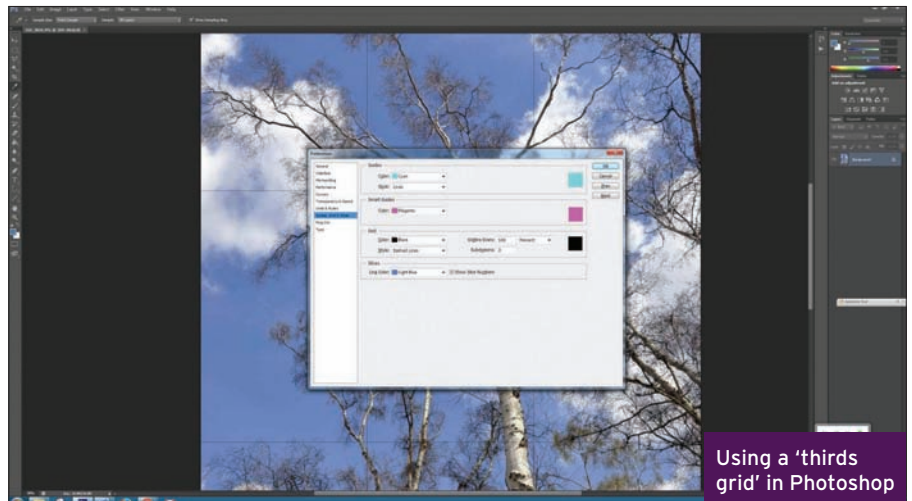
they're engrossed in what they're doing and oblivious to the camera.

Staged shots often look staged because children aren't naturally still, posed or perfectly behaved. They look best being natural, so aim to show that. The best shots of children are usually taken with a reasonably wide angle lens and at short range when they're least aware of you.

Shooting in burst mode is also a good way to catch the fleeting expressions that children often make.

9. How to photograph landscapes

Capturing a great landscape shot is usually a combination of the right light, the best location and a good composition. Light is best during the 'golden hours' (see our tip on how to get good lighting on page 85), and you can enhance any location by knowing the terrain and discovering the best aspects.

A good composition is about seeing a balance in the framing or at least capturing enough of what's there to allow you to crop it perfectly when you get home.
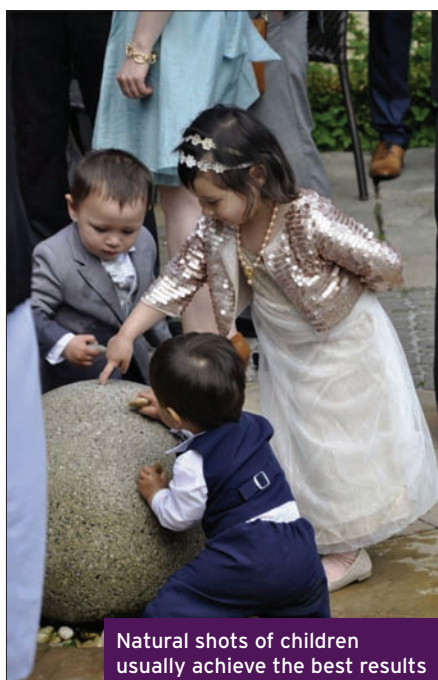

The key to achieving great sunset shots is preparation and perseverance

One way to get an interesting seascape is to wait for an especially windy day
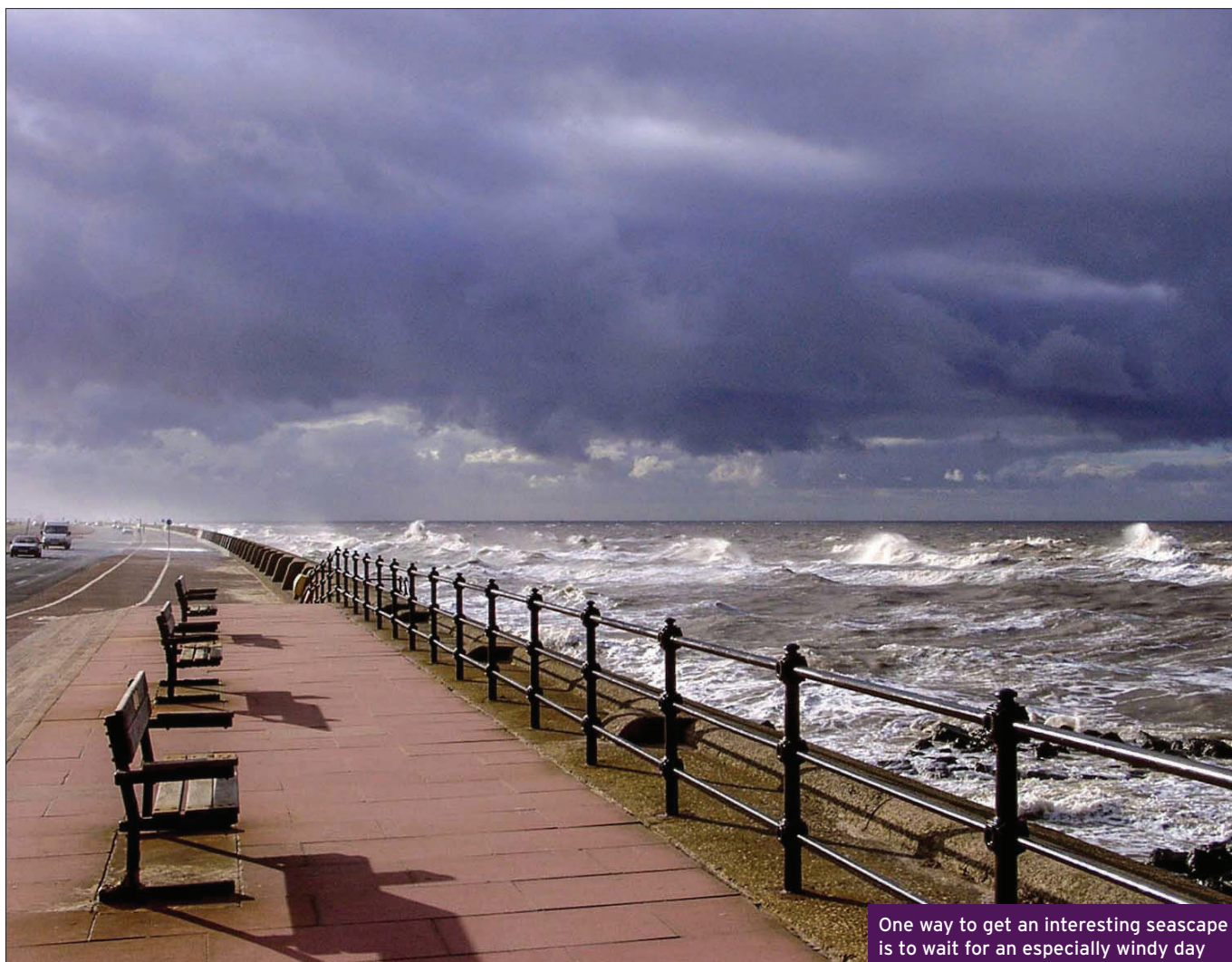
Use a narrow (f/22) aperture to make sure the entire shot is in focus. Don't be tempted to use a very wide-angle lens that misses what's interesting or dramatic in a scene,

Natural shots of children usually achieve the best results

and think about the foreground as much as the most distant objects. Creating depth in a landscape provides a context and scale.

10. How to take a better group portrait

With each added person to a group, the possibility of them all doing what you want at the same time becomes increasingly small. The real trick is, therefore, organisation. Telling everyone where they should be, and possibly where they should look.

Never take just one picture, take lots in burst mode, because you might even need to stitch the best together to get everyone to look their best at the same time.

Don't be concerned about getting in close, as unless it's a fashion shoot very few people will be concerned if their shoes aren't in shot.

11. Don't buy cheap flash cards

There was a time when flash memory was expensive, and large capacity cards could be outrageous. They're not any longer, so don't skimp on getting a decent brand and a high-speed specification.

Buy Class 10 cards, even if you're camera will work with lower specification ones. It will

make saving the shots quicker, allowing for faster burst speeds, and it will also increase the speed of transfer to the computer.

12. How to take a better selfie

The problem with smartphone selfies is that most phones front-facing cameras are rubbish compared with the rear-facing one. That's because they were designed mostly for live video conversations, and not taking still images.

There a few ways you can get around this, the most obvious being to shoot into a mirror. Alternatively, on Android and iOS, there are plenty of apps that can identify a face and will tell you when you've aligned the phone correctly to take a picture without having a screen to see. This method

Light, location and composition are all important for successful landscape photography

Selfie lens

can work, but not reliably. Another method to improve your results is to buy a selfie lens.

These can either give your front facing camera a wide-angle/fisheye modification, enabling you can see more of your surroundings and less of you in the frame.

13. How to improve low light or night photos

It might seem obvious, but you should disable the flash unless you want to illuminate

something nearby. And then, if you do then use a flash extension cable and flash from the side rather than from the camera. All night/dark photos are a fine balance between capturing a clear image, shutter speed and the graininess that high ISO values can introduce.

Use shutter priority to set 1/30 speed, ISO to 800, and use the f-stop as the flexible parameter. If you have something to rest the camera on, you can go to 1/15 and depending

on the camera push the ISO even higher. In general, don't use a flash, even if the camera will always use one in automatic mode.

Turning the flash off vastly improved this scene taken in a cave (see page 86).

14. How to get good lighting

Shooting on an overcast day with indistinct shadows can suck all the life out of any amazing vista. The best times of the day to shoot are the 'golden hours', just after dawn and before dusk. At this time you should still get plenty of light, long shadows and an attractive colour component.

Avoid midday, when the sun is directly overhead, and also consider that when

The real trick for group shots is organisation, directing everyone where they should be and where to look

you've plenty of reflective surfaces such as the seaside, the amount of light bouncing around can send shutter speeds very high even at 100 ISO settings.

Professional photographers are always pursuing 'good light', and that's mostly about being prepared to get up early or wait for the right conditions to prevail.

15. When to use a polariser

Some photographers always have a polarising filter installed, but there are only limited situations where they're a necessity. Its job is to cut down light that's scattered by atmospherics or is coming in at sharp angles causing glare.

They work best when the sun is either directly behind you or up to 90 degrees left or right, while in the direction of the sun they have no impact at all. Shooting water, misty landscapes and delicate cloud formations benefit most.

The downside of using them is that along with diffused light reduction they also tend to notch the colour saturation down too. Because of this avoid using one to capture a sunset or fireworks.

The best results from using a polariser come from water photography, where you can rotate the filter to provide the perfect amount of refracted light removal. Just watch out for zoom lenses that rotate the end of the lens as they extend/retract, because that will alter the amount of polarisation you see.

Flash is used on the left, and not on the right

On the left is a photo taken with no polariser. Using a polarising filter makes the sky extra blue and gives cloud details more punch.

16. How to shoot HDR on a DSLR

HDR or High-dynamic-range is a technique that's become very popular since the inception of the digital photography. The idea is to capture multiple exposures and then combine them in post-production to provide a much wider dynamic range than the sensor could achieve in a single shot.

Most cameras have an built-in HDR mode, but the best results come from using exposure bracketing and assembling the image away from the camera.

Typically, exposure bracketing allows three, five or seven images to be fired off in rapid succession, with a different exposure on each. The exact increment and centre point of exposure are usually definable in

17. How to use reflections

When shooting reflections you need to focus on exactly what the reflective surface is presenting, often that being the sky. If the sky or background isn't interesting, then it doesn't matter how perfect the water or shiny the chrome, it won't generate anything visually exciting. You just might need to wait for the weather to change, or alter your viewpoint.

Being able to see these possibilities is part of becoming a photographer.

Here's a nice shot of geese (below), but very little interest in the water reflections. Contrasted with one (right) where the sky and background provide a wonderfully colourful backdrop to the feeding bird.

Without polariser

With polariser
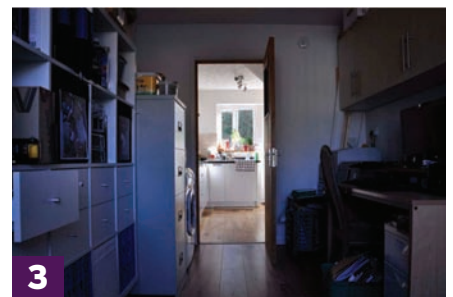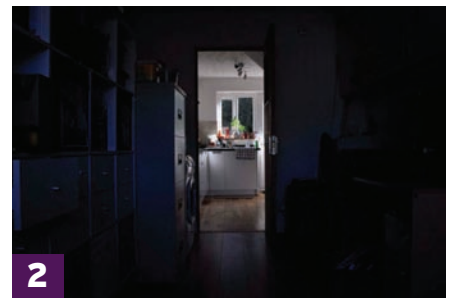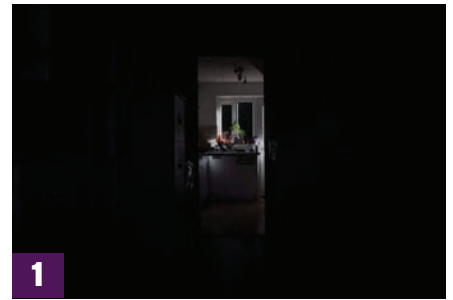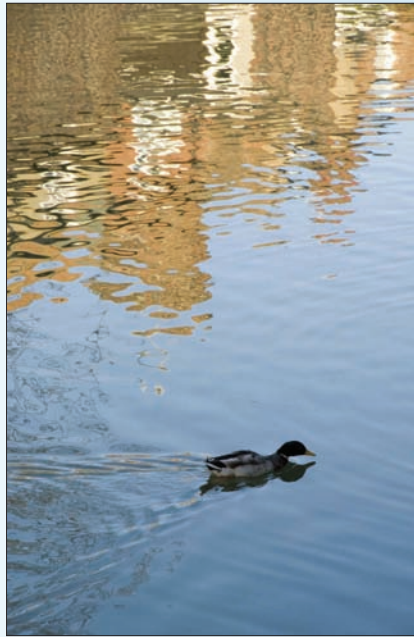
the camera settings, as is the increment. When the images are recombined on the PC (or Mac) using Photoshop or the many free HDR tools available, you should end up with detailed shadows without blown-out highlights. Because of the time delay between shots, it is best to restrict this technique to static scenes and avoid moving subjects. And, unless you've got a very rapid burst mode and strong light, using a tripod is also a necessity.

Photos 1, 2 and 3 (above) were taken at different exposures. The three shots are recombined in software to create one image (4) with enhanced dynamic range.

18. HDR from a single image

If you've only a single image, you can still process it to get the very best out of the captured data within it, especially if you use a RAW file format.

Unprocessed image
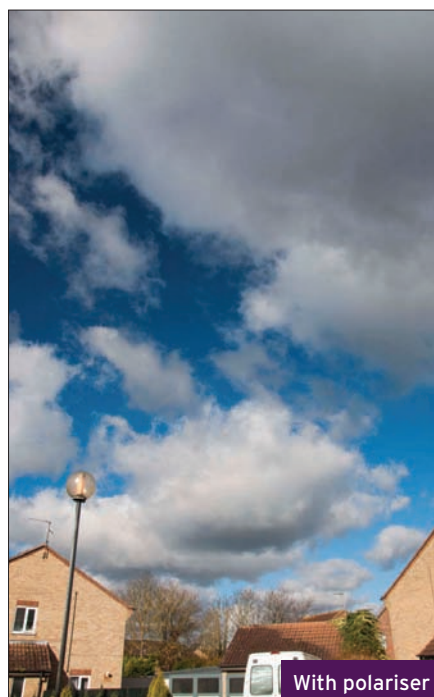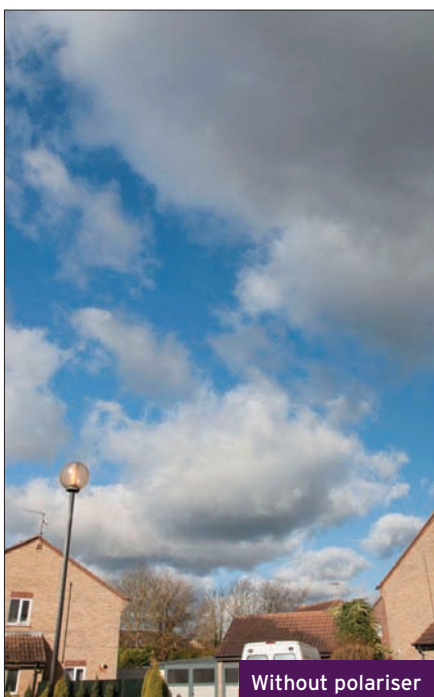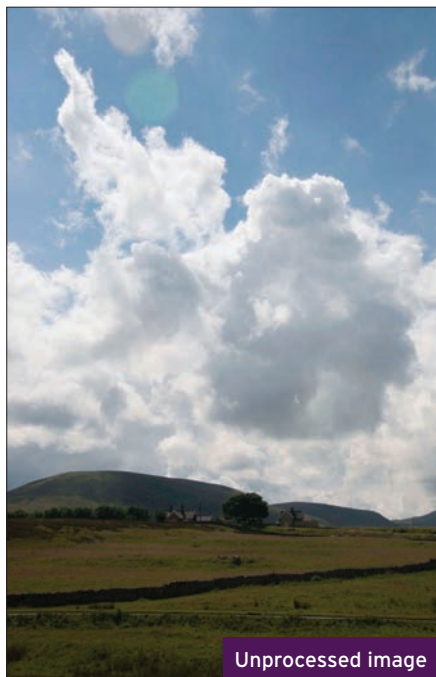
Using a Photoshop plugin like HDR Efex Pro 2 (free from Google) or standalone PC applications such as Luminance HDR, significant amounts of detail can be extracted from one image.

Alternatively, you can take any image and alter the levels to bring out the shadow and highlight details, saving them as separate images, and then recombine them for HDR processing.

Even using a single RAW image, you'll be impressed with what tone mapping can pull out of what looks like a rather unexciting and flat image. Processing a single image using tonal mapping tools can exploit the hidden data in an image.
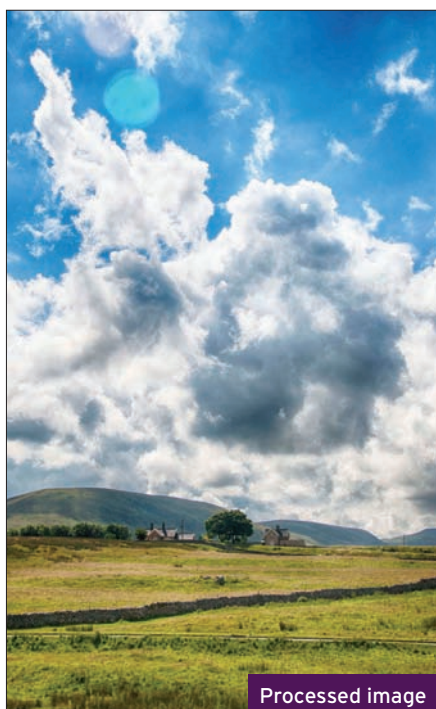
19. How to shoot in black and white

Digital black and white is shooting colour with the intention to eliminate it later, even if you use the hue data in post processing. Most cameras offer a black and white viewfinder mode or in-camera processing. Nikon, for example, will convert the JPG to black and white, while shooting in RAW+JPG, though the RAW will still contain colour. It then shows you the mono JPG on the viewfinder. These features help, but it's also down to the photographer's eye to see the light and dark within the frame and understand how that might work in monochrome.

Photoshop has excellent control over the conversion process, letting you reduce or

enhance different channels, making it one of the best tools for black and white to work. You can do this at the camera with coloured filters, but that limits the options available to you in post processing. However skilled you are with using these features, the real trick is to pick subjects with high contrast that don't rely on colour for composition or impact.

As shown above, low contrast scenes or ones with strong colour don't convert well. However, those with high contrast can look spectacular (see below)

20. The tilt-shift technique

The use of perspective control lenses goes back a long time, with Nikon selling

Processed image
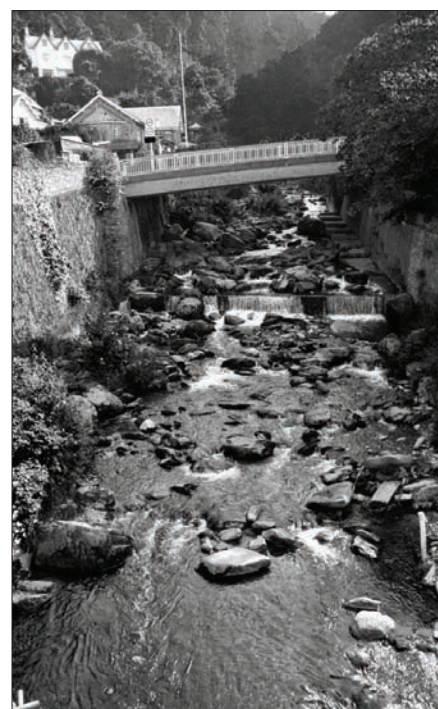
Before 'tilt-shift' technique

After 'tilt-shift' technique

the first one for their SLR cameras back in 1962. You can still buy these devices, and they are often used by architecture photographers to shoot tall buildings.

However, most digital photographers use a software simulation of the effect on the computer to take an image and tinker with the perspective and focus. The common use is to fake miniature scenes with real locations, but they can also solve the perspective issue of shooting large objects from relatively low level.

Many tilt-shift shots are often taken from an elevated location, simulating a viewing angle is the one that you'd experience looking down on a model city/scene.

You can buy a proper tilt shifting lens, or use software (such as Photoshop or Lightroom) instead that usually offers more control. Plenty of phone apps have a tilt-shift effect, too.

## 21. Shooting Panoramas on a DSLR

The most basic requirement for doing good panoramas with a camera is a tripod. Using one allows the camera to pan accurately, and avoid unintentional pitch angle changes.

At least a third of each frame should overlap the next, and much more overlap if there are foreground objects close to you. Having a grid with 'thirds' active is good if you have that, and any viewfinder grid is a useful reference. For those wanting the very best quality creating a horizontal panorama should consider shooting in portrait mode, as it will give you the best vertical resolution. And, always use exposure lock, so that all the images end up with the same light levels.

There are special tripod mounts available to help shoot panoramic, though you'd need to be very keen on them to invest in one of these. Those with even greater resources should buy a drone, for the ultimate panoramic results. A Panorama can be vertical and not horizontal, especially if you've got access to a drone (see right).

A Panorama can be vertical and not horizontal, especially if you've got access to a drone
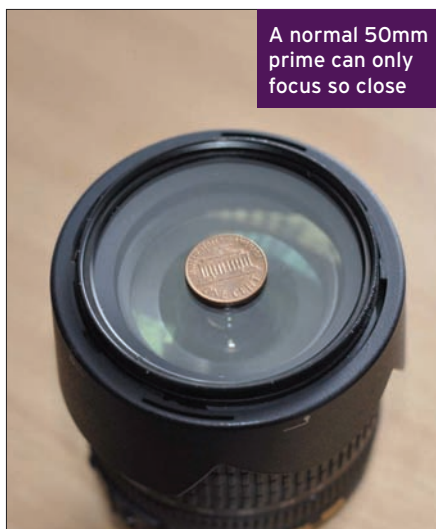
A normal 50mm prime can only focus so close
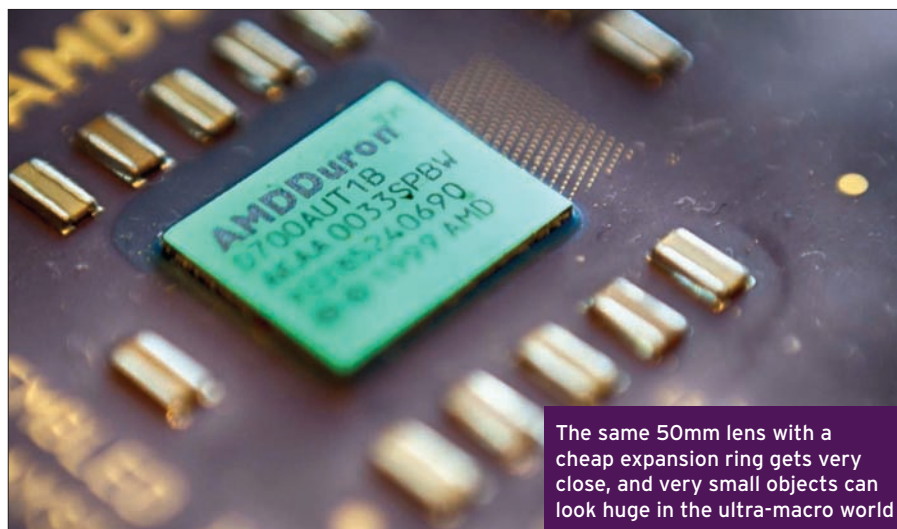
The same 50mm lens with a cheap expansion ring gets very close, and very small objects can look huge in the ultra-macro world

22. No macro lens, no problem

Shooting small objects is problematic because most standard lenses won't focus on anything very close. The answer is a Macro lens, although even these have limits as to exactly how close they will work.

A cheap workaround that offers amazing results is a reversing ring that allows you to attach a lens backwards to the DSLR. These cost very little, less than £5, and can allow you to capture stunning macro shots without a macro lens.

These rings work best with old manual focus lenses. They can also be found very cheaply online if you need one. The other prerequisites include a good tripod, a shutter release to avoid shake and a DSLR that will still shoot when it thinks no lens is attached.

As the lens won't be electronically connected to the camera, focusing will be manual, and you'll need to adjust shutter speed to achieve the perfect exposure. Top get enough light into the lens wedge out the aperture control with something stable, a blob of Blu-Tack comes in handy.

The rest is about experimentation, and dealing with having a very small part of the object in perfect focus. Get all this right, and you can achieve some stunning results.

23. Use a wide-angle, prime or telephoto lens

It's tempting when many DSLR cameras come with a very good kit lens to just use that and entirely negate the real reason for owning a DSLR over a bridge camera. After the outlay on a DSLR starter kit, further immediate investment is often the issue.

However, having a decent wide angle, telephoto and a good prime lens are essential for anyone wanting to take photography seriously. What many don't realise is that you can get good lenses for many systems at very low prices, if they accept a few limitations.

Older lenses, some even pre-DSLR, will usually fit onto a modern body, with the

Using a reversing ring and some Blu-Tack the lens can be flipped

24. Experiment with framing

We've all seen enough photos where people are half-in-shot or missing the tops of their heads to realise how important framing can be. But, sometimes picking an interesting angle or cropping the subject can improve a photo rather than detract from it.

Here are three images of a hot air balloon. The first is the balloon in its entirety, nice but not very exciting. The second is better because the burner creates extra interest. The third is equally pleasing because the angle says something about how balloons travel, up-up-and-away.

You have very little to lose by framing in less obvious ways, so try it.

3

1

2

They're also useful on drone cameras to avoid choppy video caused by high shutter speeds removing all the motion blur. Reducing the light entering the lens can be useful

limitations being that the autofocus won't work and the automatic aperture control might also be disabled. For prime lenses, these aren't massive issues, and the result of using a cheap 50mm f/1.8 lens over the stock 18- to 70mm f/3.5 is huge when shooting portraits. And when we say cheap, you really can pick these up for around £60 to £70. Get cheaper old or lower quality new lenses to start, and then when you've learned to appreciate what they can do it's easier to justify an investment in better glass.

25. When to use ND Filters

Neutral density filters appear to do something most photographers wouldn't want, as they cut the amount of light entering the camera. However, there are some situations where you'll require a short focal length at ISO 100, but not a high shutter speed. Because motion blur being visible

on the wings of a hovering bee might be preferable, for example. The ND filter enables you to reduce the incoming light without altering the aperture and ending up with a deeper than intended depth of field.

They're also very useful on drone cameras to avoid choppy video caused by high shutter speeds removing all the motion blur. It might seem counter-intuitive, but reducing the light entering the lens can be useful. ☒

Install Windows on an external hard drive

USB 3.1 can make it almost as fast as an internal drive. Samuel Axon shows how

Thanks to the speed of USB 3.1 and USB-C connections, it's now possible for an external hard drive to match the read and write speeds of an internal drive. Combine that with a proliferation of external SSDs, and for the first time running Windows off an external drive is viable.

Before we start, let's get the bad news out of the way: Windows will refuse to install on an external drive if it knows that's what you're doing. But there are a few ways around this, including emulation via tools such as VMware. The easiest workaround is an application called WinToUSB (tinyurl.com/oaqx29q).

WinToUSB serves the same function as Windows To Go, an enterprise-only tool from Microsoft that doesn't work with most consumer versions of Windows. It's intended for use with USB sticks, but it will work for other external drives too.

If you already have a DVD, an image file or an installation USB stick for Windows, you're set on this one. If not, it's easy to download a Windows 10 installer ISO image file directly from Microsoft. Just make sure you pick the image for the edition and language of Windows for which you own a license. If you're just cloning your current Windows installation, skip this step.

Tell WinToUSB where Windows is
The icons along the left of WinToUSB let you choose the media from which to install Windows: an image file, DVD, or clone of the current system installation. Pick the one that applies.
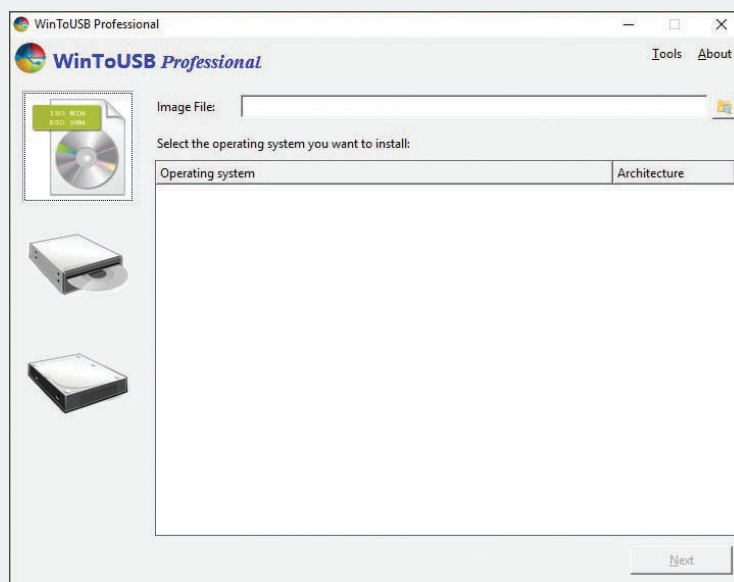
Once you've done that, you may see some options under the 'Operating system' column in the main window. Pick the one that matches the license you have. For example, if you're installing from the official image file, you'll be able to choose between Home and Pro. Click Next.
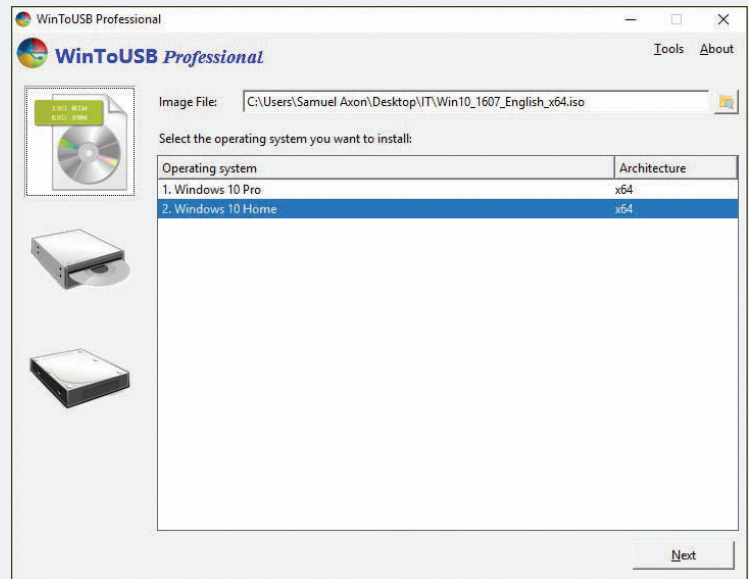
Select the installation disk, partition and mode

On the next screen, use the drop-down labelled 'Please select the destination disk'. At the top to pick the external drive you want to install Windows to. This will open up a bunch of options below that. You'll be asked to pick the system and boot partitions. If the external drive isn't split into multiple partitions, you can easily just pick the available partition for both system and boot.

Finally, you'll be presented with Installation mode. If you can, pick Legacy mode; that's the simplest way to go. Only try installing Windows in VHD mode if you have issues installing Legacy. You'll also be given the option to configure the size of the Windows installation on the drive; just go with the maximum available unless you're doing something special. Click Next to get the installation started. You'll see a progress percentage. The time it takes to install will depend on a number of factors, such as the speed of the destination drive. It could be 15 minutes, or it could be a couple of hours. You'll be prompted when it's done.
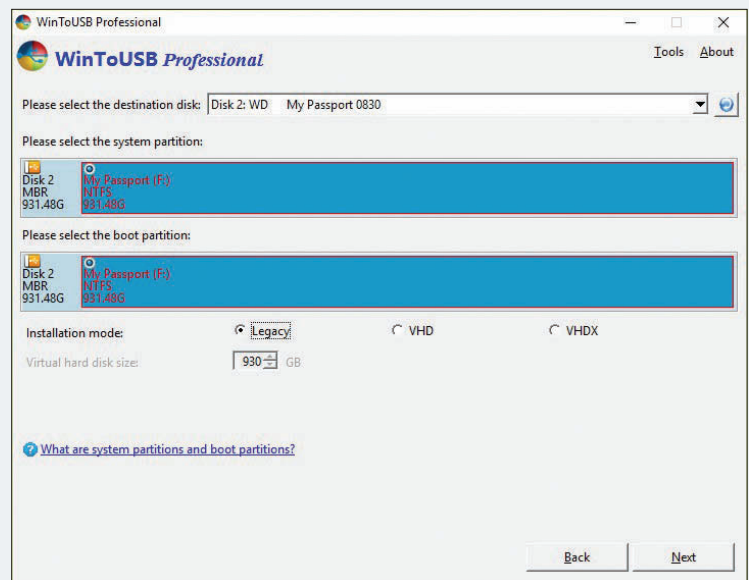
Boot into Windows

After the WinToGo process is complete, all you have to do is boot into Windows. To do this, restart your computer and boot from the external drive.

Unfortunately, the method for selecting which disk to boot from after restart varies among computers. Often, you just have to press F12 while the PC is booting to access the BIOS, where you will make this change. Barring that, pay attention to the motherboard-maker screen that appears when your PC boots (prior to loading the OS) – it will flash instructions for accessing the BIOS.

You should be presented with a selection of drives to boot from. Pick the external drive (it's usually labelled 'EFI Boot' by WinToGo, if that helps). Windows installation should complete with a simple wizard from there.

Of course, you may have to download drivers and the like – the usual extras that come with a new Windows installation. But after a little legwork, you will have a fully functional installation of Windows on your external hard drive. ⊠
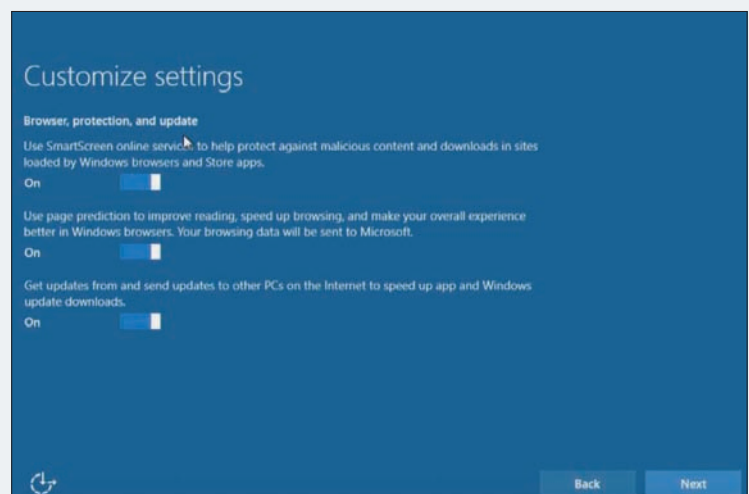
Use Process Explorer to manage your PC

This alternative to Task Manager makes Microsoft's built-in offering obsolete, writes Mike VanHelder

If you use Windows, there's a good chance you'll have used the built-in Task Manager. Whether it's to kill a frozen process, track down some malware, or figure out what's eating up all that memory, the Task Manager is an invaluable tool for any intermediate or advanced user. But for enthusiasts that want extra control, more information, and a host of extra features, there's a more powerful alternative available: Microsoft's free Process Explorer tool.

Process Explorer isn't just a supercharged version of Task Manager with more insight and control over your system's processes. It also includes the ability to sniff out viruses and identify when programs are clinging to software you want to delete.

Part of the Sysinternals suite of Windows tools (formerly 'Winternals'), Process Explorer can be downloaded from TechNet a la carte or as part of the entire suite. If you plan on completely replacing the Task Manager with Process Explorer – and eventually you probably will – you should get the whole suite. More on that later. Here are just a few of the things you can do with Process Explorer – available at tinyurl.com/o7k92tu.

The basics

When you first open Process Explorer, there's a lot of information there and it can look overwhelming. Don't panic. Here's what everything is.

In the top half of the main window, you'll see a list of processes. This shouldn't be completely unfamiliar if you've used the Details tab in Task Manager (aka the Processes tab in Windows XP and earlier). It lists the process name, the process description, CPU and memory usage, and the company name of the software's creator – something that's very useful when you're malware hunting. You can customise your columns to include more or less information by right-clicking on the column heading, just like any other program with sortable columns.

The processes are presented hierarchically, which means if a process spawns another process, the child process will be listed nested underneath the parent. If you'd prefer an alphabetical listing instead, just click the 'process name' column heading. This list is constantly updating, but if you want to freeze it in time – say, to examine a process that appears and disappears quicker than you can click on it – you can hit the space bar to pause the updates.

There's a lot more information here – the scrolling line charts at the top of the window, the colour codes, the lower pane showing DLLs and handles – but for now let's focus on the process list. There's a good chance you might find a group exists, and joining this will put you in touch with plenty of people who might be able to aid you in your quest.
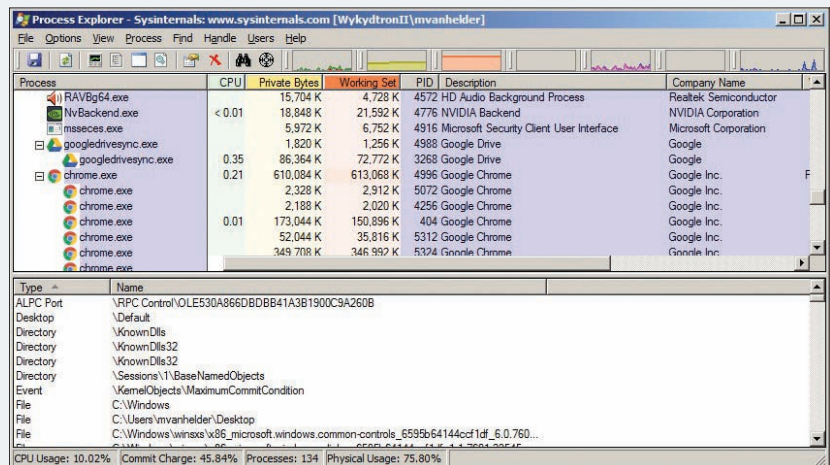
Search your email contacts

Many people have used Task Manager to end a misbehaving process at some time or another. This functionality exists in Process Explorer as well, where it's called Kill Process when you right-click a process. Process Explorer does one better than the stock Windows Task Manager by giving you the option to kill the entire process tree. Right-click a process, then click Kill Process Tree; or select Process > Kill Process Tree; or just highlight your process and hit Shift - Del.

Why would you want to kill a whole process tree? Sometimes when a process stalls out, it's not the real culprit. Instead, one of the child processes it has spawned is the actual bad seed (we're looking at you, Chrome). Even when the original process is the true villain of the story, killing it can sometimes leave orphan processes behind that can't do anything without their parent, but which suck up resources anyway. Killing the process tree solves both problems at once.
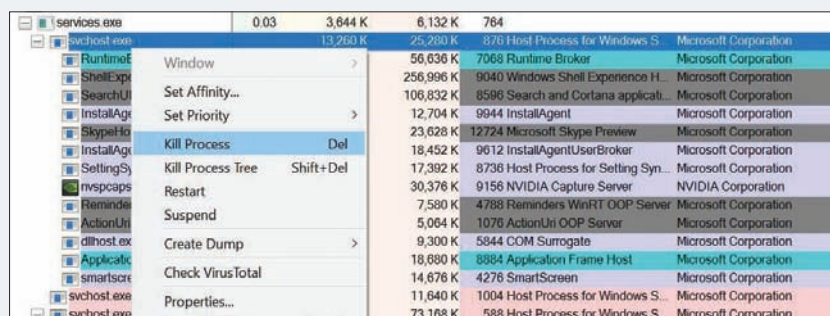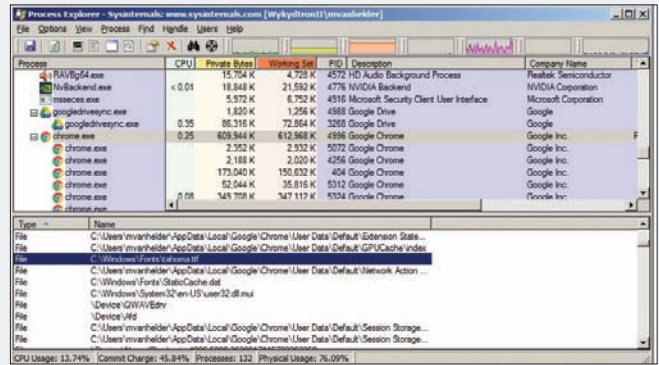
Find out which process has a file locked

One of the most frustrating things that Windows users run into on a regular basis is trying to edit or delete a file only to get some variation of the old 'This file is open in another program' or 'This file is locked for editing' message. If you're a multitasker and you have a dozen windows open, figuring out which one is locking down your target can be an exercise in wasting time. Process Explorer offers a solution.

Open Process Explorer, select a process, and hit Ctrl + H. That changes the lower pane to 'Handle View'. This will show you every file, folder, subprocess and thread that the process has open. If you suspect you know what process is locking your file and want to confirm, this is where you do it.

But what if you don't know which process is holding your file hostage? Are you supposed to go through every process in the list hunting for your file? You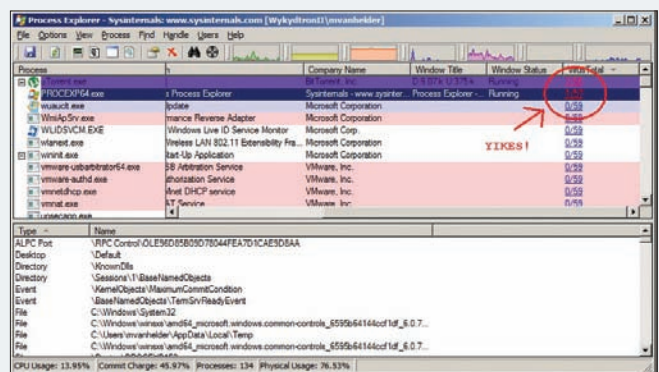 could, but there's a much easier way: Click Find > Find Handle or DLL, or use the Ctrl + F keyboard shortcut. Just type your filename, and it'll tell you which process is locking that file.

Is this a virus?

Process Explorer is especially useful if you're hunting malware. For some really in-depth examples, you can always check out Mark Russinovich's world-class 'The Case Of…' series of blog posts and videos. But you don't need to be a malware-busting pro like Russinovich to figure out whether a suspicious-looking process is a virus. Process Explorer uses VirusTotal, a Google project that checks questionable processes against the databases of all the major antivirus companies.

First, click the suspicious process, then go to Options > VirusTotal.com > Check VirusTotal.com. (The same path is also available via the right-click menu.) If this is the very first time you've scanned a process, it will take you to the VirusTotal Terms of Service. Otherwise, it adds a VirusTotal column to Process Explorer.

This column shows the number of antivirus services that have flagged that particular process as a potential virus. For example, '7/59' means that seven out of 59 total antivirus providers think that the process is potentially hazardous. The higher the number, the more likely it is that the process is actually malware. For more information, just click the numbers to open the VirusTotal website, where you can learn more. Obviously, like any other antivirus measure, this isn't foolproof, and you can get false positives. For example, Process Explorer itself is occasionally flagged as hazardous. Also, viruses may be too new to have been widely flagged, or they could be deploying any number of anti-antimalware techniques. Nevertheless, Process Explorer's VirusTotal integration is a very good start.
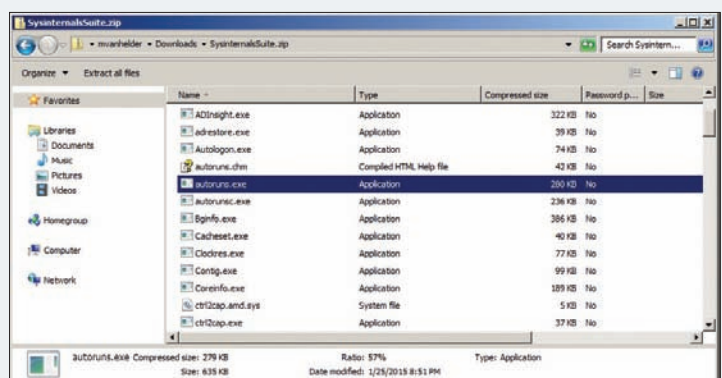
Replacing Task Manager entirely

Once you get comfortable with it, you'll discover that Process Explorer is better at managing tasks than Task Manager in almost every way, and you'll never want to open Task Manager again. Process Explorer can help you out with that.

In the Options menu, you'll see an item labelled Replace Task Manager. Select that, and every action that would normally have triggered Task Manager, whether you invoke it from the command prompt or select it from the Ctrl + Alt + Delete menu, launches Process Explorer instead. In Windows XP and earlier, that's all you need to do, but in Windows 8 and 10, there's a twist.

The Windows 8 and 10 versions of Task Manager don't just manage processes. They also now handle startup items and service management, which were located in MSConfig in earlier versions of Windows. If you replace that version of Task Manager with Process Explorer, will you lose functionality? When it comes to services, no. The default Services app built into Windows (just type Services into your Start menu and you'll find it) handles managing your services just fine.

But when it comes to startup items, yes – you will lose functionality. Process Explorer doesn't handle those at all, so you'll need another tool for that. That's why we recommend that you download the entire Sysinternals suite if you want to replace Task Manager altogether. There's a utility in there called Autoruns that absolutely blows Task Manager's startup-item functionality out of the water. How to use Autoruns is a subject for a different article, but you'll want to extract that and keep it somewhere handy for when you want to give your startup a tune-up.

Most people will use Process Explorer for the features we've outlined here, but dig deeper and you'll find even more power-user tools in its nooks and crannies. If you really want to get nitty-gritty, you can find more details in Process Explorer's amazingly deep Help files. ⊠
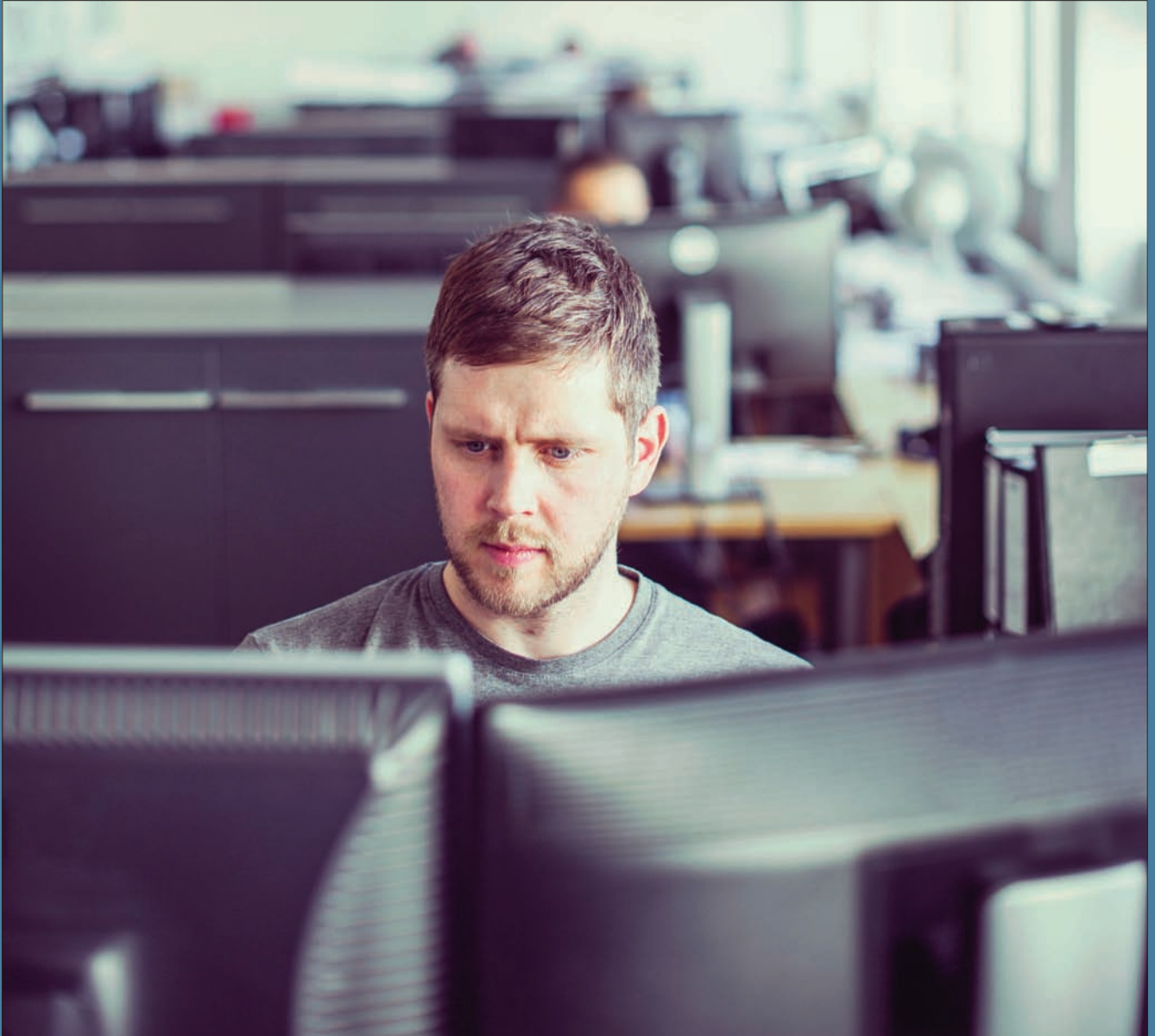
Switch between open windows of the same app

Ian Paul reveals a handy third-party that allows you to move between open windows of the same app

Switching between multiple open windows of the same program is a problem we try to solve in several ways. Sometimes you have applications that use tabs to view multiple files in one window. For those that don't, users often turn to Windows' Snap function or multiple monitors.

This tip uses a different solution by importing a longtime keyboard shortcut from the Mac, Alt + ` (back tick). (The Mac version uses Cmd instead of Alt.) This simple keyboard shortcut, which you can easily hit with the same hand, automatically switches between multiple windows in the same program.

You can accomplish something similar with Windows' tried-and-true Alt + Tab, but that shortcut switches between every open window on your desktop.

There are several programs that offer the back tick solution, but one is relatively new: Easy Windows Switcher from NeoSmart

Technologies (tinyurl.com/lfLamyL). It's a simple, behind-the-scenes program that's only purpose is to let you hit Alt + ` to switch between windows from the same desktop application.

To install it, head over to the company's site (link above) and download the EXE file. The site asks for your name and email before downloading, but handing that information over is not a requirement. Just hit the Download button and you'll be ready to go. Now click on the EXE file, and a properties window will open asking if you want to run Easy Windows Switcher for the current user session or to always have it run for the current user account. Choose whichever you prefer and that's it. Open a program, hit Alt + ` and you'll be switching between open windows in no time.

If Easy Windows Switcher isn't for you, there's also VistaSwitcher, a program we haven't looked at since 2009 (it still works), but offers the back tick shortcut among other features. ⊠

Buy and read books in Microsoft's browser

Ian Paul reveals how to get the most from Microsoft's ebook purchasing experience

As part of the blitz of new features in the Windows 10 Creators Update (read our review on page 20), Microsoft has added e-reading capabilities to its Edge browser. It's a bit quirky, given its infancy, but with a bit of practice you can be lounging by the pool with an electronic novel in no time.

The first question you'll ask: Does it surpass Amazon's Kindle app. Well, sort of: the Kindle app available for Windows tablets rejected my (correct) Amazon password, a bug that numerous other users have reported. (The Kindle for PC app buried within Amazon's site works, however).

Edge offers pretty much what you want from an e-reader app anyway: a progress bar, the ability to resume where you left off (mostly), and solid text-formatting options. Reading ebooks is also an opportunity to take full advantage of a detachable Surface tablet, as opposed to a traditional notebook PC.
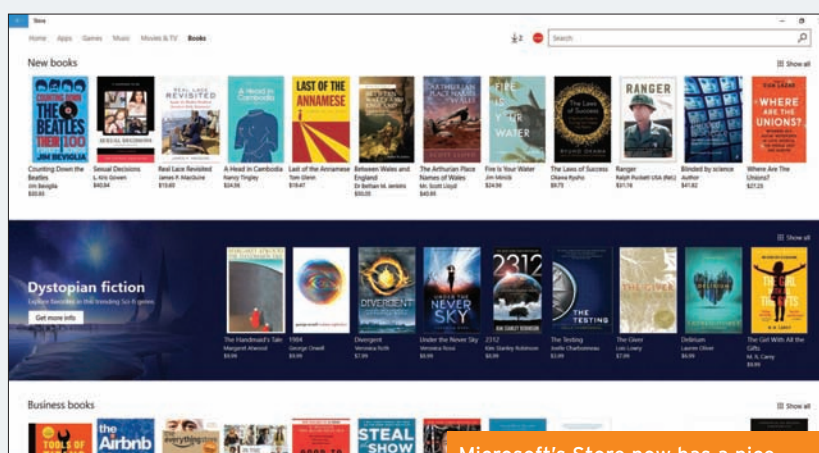
Microsoft's Store now has a nice collection of ebooks to go along with its movies, music, apps, and more

The Windows Store makes buying ebooks easy

Windows' ebook-buying process begins with Windows 10's Store app, which as of the Creators Update adds an ebook store alongside its selection of apps, games, music, and movies. All told, the Store app has evolved into a respectable marketplace.

Not surprisingly, the ebook store looks remarkably like the other categories: At the top of the screen are a few 'hero' selections, a handy link to some free classics, and some links to 'top' and 'featured' books. How many books does Microsoft offer? "Hundreds of thousands," according to a company representative, with plans to offer *New York Times* bestsellers as well as other top titles across a range of genres.

Scroll down, and you'll see the handiwork of Microsoft's curators, with collections of different genres and other featured works. Though there's a search box, you can't do something as basic as search for 'cookbooks'. That term appears in the genre-based collections at the bottom of the main page, however.

As we were writing this, Microsoft had not highlighted any sales or discounts, something the company will need to do if it truly wants to challenge in the market. Amazon, for example, competes notoriously hard on price. Disappointingly, some books, such as the Harry Potter series, simply weren't available in the Microsoft Store at the time of writing.
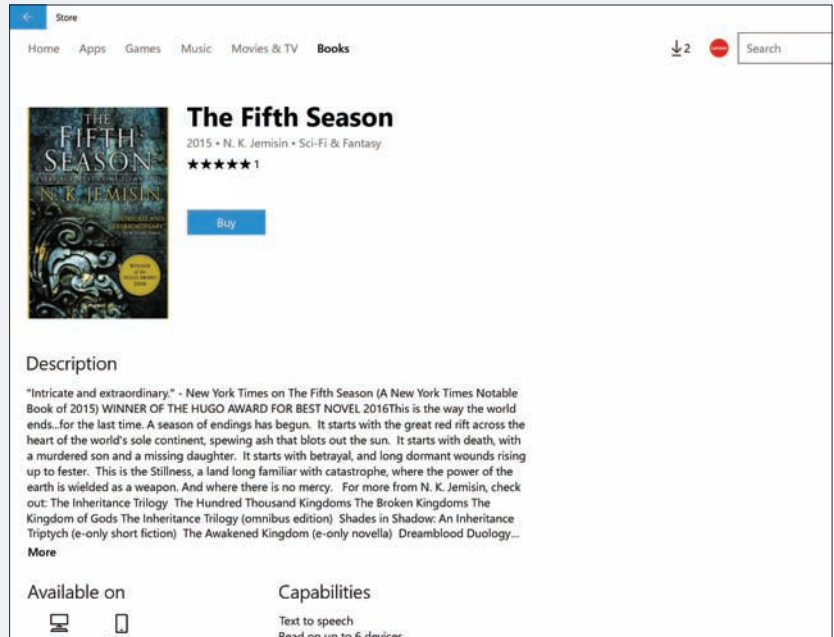
If you're the type of person who reads a band's biographical info in Groove Music, you'll notice a similarity: massive blocks of summary text

Microsoft's individual descriptions of the books are a bit sparse, lacking previews or any art beyond the illustration on the book jacket. Since Edge's e-reader only supports DRM-protected books in the EPUB format, that's all you'll find inside the Store. (Edge itself includes a PDF reader, too.)

If you choose to buy a book, Microsoft uses any stored payment information you have inside its system to charge you. Unfortunately, there are no refunds or trial periods. What's nice, though, is that Microsoft defaults to using biometric identification within Windows Hello to streamline the purchase, if your device supports it. (If it doesn't, you can use a PIN or password instead.)
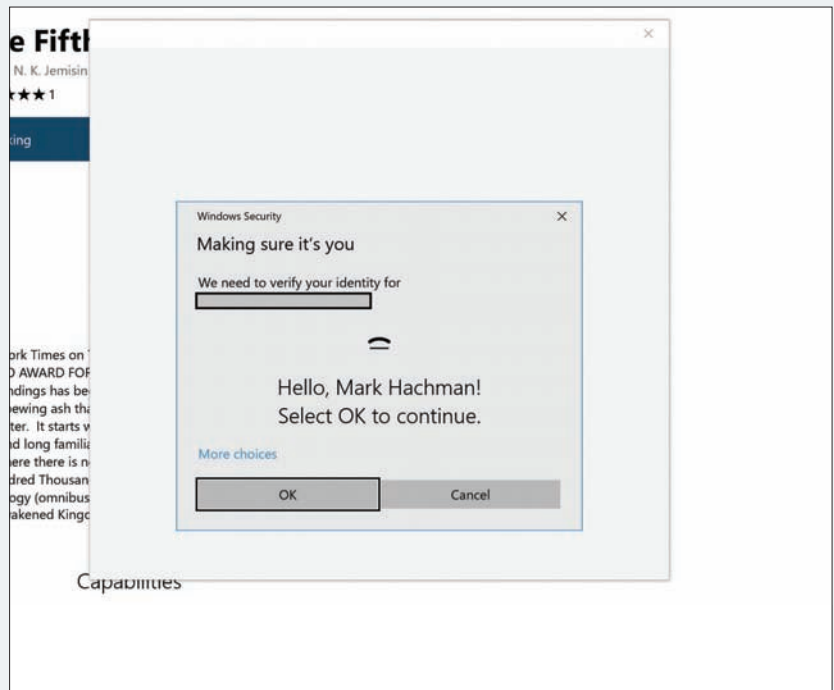
Purchasing an ebook is easy

The Edge easy e-reading experience

Once you've purchased an ebook, feel free to open it immediately. Otherwise, you'll be off on a hunt – where is my ebook library, again? Instead of tucking shortcuts to your library all over the place, you'll need to return to the Store's main 'Books' home page, and then click the My books link.

Doing so will launch Edge. Unfortunately, Edge opened my 'Reading List' – a collection of web pages I stored to read later – and not my collection of ebooks. Even in Edge, 'Books' isn't found intuitively; you'll need to navigate to the Hub – the icon to the right of the 'star' in the URL bar – then navigate to the icon that looks like a collection of books leaning against one another. Microsoft might not force you to open a separate app to read an ebook, but that doesn't mean it's any easier a process.

The Microsoft Edge Hub, in which your ebooks are stored within the Books section
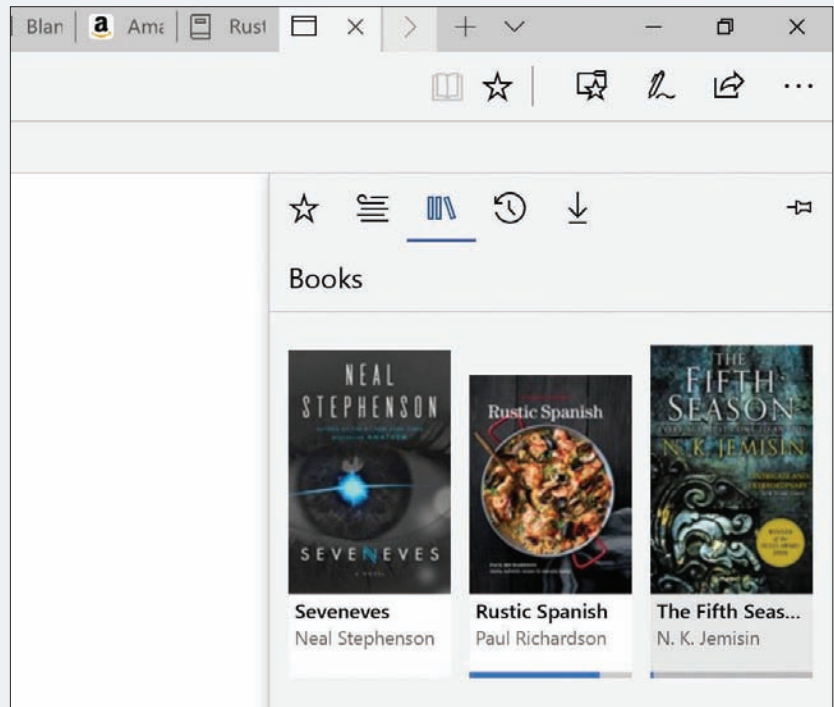
Within the Books sidebar, you'll see your collection of books, with a progress bar showing how much you've read. At the bottom of the sidebar is a link back to the Store.

Once an ebook is opened in Edge, navigating its contents is simple enough. Edge will open the book to the title page, possibly (depending upon how the book itself is organised) with a list of hyperlinked chapters. At the bottom of the screen you'll see the title of the book, the chapter (if any) and your progress as a percentage of the book.

Lush, lavish cookbooks lose a little something in the EPUB format, though traditional text-heavy books look just fine
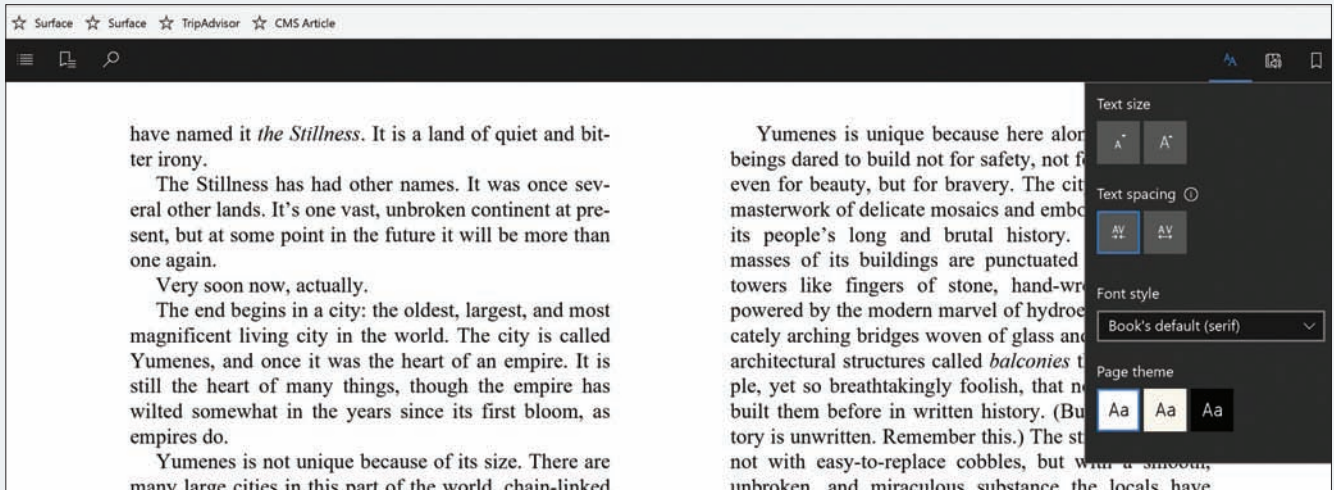
More options open up if you tap the screen, which reveals a black border at the top of the page. At the upper left there's an icon that displays the table of contents, which slides out from the left. Click the icon next to that and any bookmarks you've saved will appear. Edge also includes a search function to look for specific terms.

In the right-hand corner, the Options icon (alternatively Ctrl + Shift + O) lets you adjust text font, size, colour, and spacing. There's also an icon to 'read aloud' via text-to-speech, which also lets you adjust pacing, evidence of Microsoft's commitment to assisting those with vision problems (although there doesn't seem to be a hands-free Cortana command to 'read my ebook' – hopefully that's forthcoming). There's also an icon to set bookmarks within your ebook, one per page.

Unfortunately, features you might expect in an e-reader app, and which are available elsewhere in Windows – inking, highlighting, sticky notes, titled bookmarks – haven't yet made it to Edge's e-reading experience. If you stop reading an ebook – say, because

Windows 10 unexpectedly reboots your PC – your progress will be saved. That's how it's supposed to work, anyway. As we were evaluating Edge using a build of the Windows 10 Creators Update that Microsoft provided to journalists, the operating system updated to a new build – forcing us to redownload all of our books and losing our progress. That needs to be fixed.

Unfortunately, Microsoft's mobile ebook experience is limited to the small number of Windows phones or tablets in existence, as Microsoft doesn't make a version of Edge for Android or iOS. That's a serious and unfortunate handicap for train or bus commuters. Since Microsoft does include a browser inside its Bing app for both mobile platforms, it's at least theoretically possible that this capability could be added later.

For now, you've probably already settled on an ebook format and reader. If Microsoft launches its ebook store with a splashy sale, however, you could be lured in. And aside from the obvious mobile limitations, reading ebooks within Edge isn't half bad. ⊠

Create a drop-down list in Microsoft Excel

Drop-down lists help you save space on a spreadsheet. Martyn Casserly shows how to make them

Set the contents of list

START The first thing you'll need to do is open up a new Excel worksheet. In the left-most column enter the various contents you want to appear in your list. Each entry needs to occupy one cell, have no blank cells between them, and all must reside in the same column.
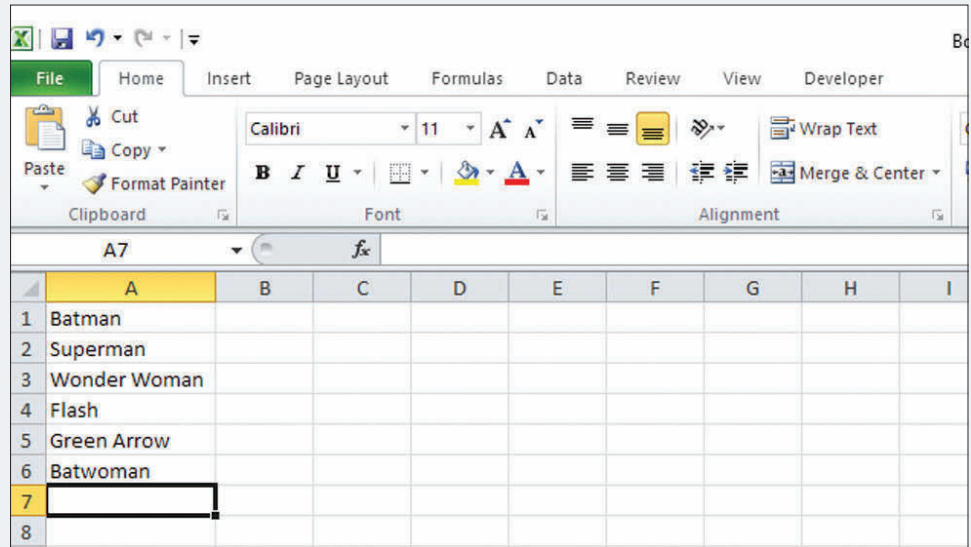
2 When you've assembled your list, highlight all of the entries and right-click on them. From the menu that appears select Define Name.
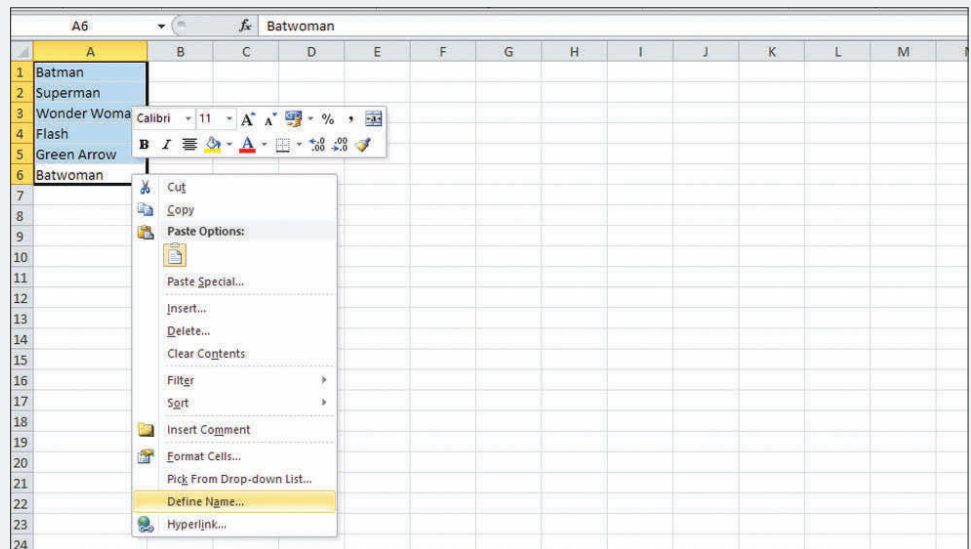
3 This brings up a window with the heading New Name. In the Name field enter a title for your drop-down list, being sure not to include any spaces. Now click OK.
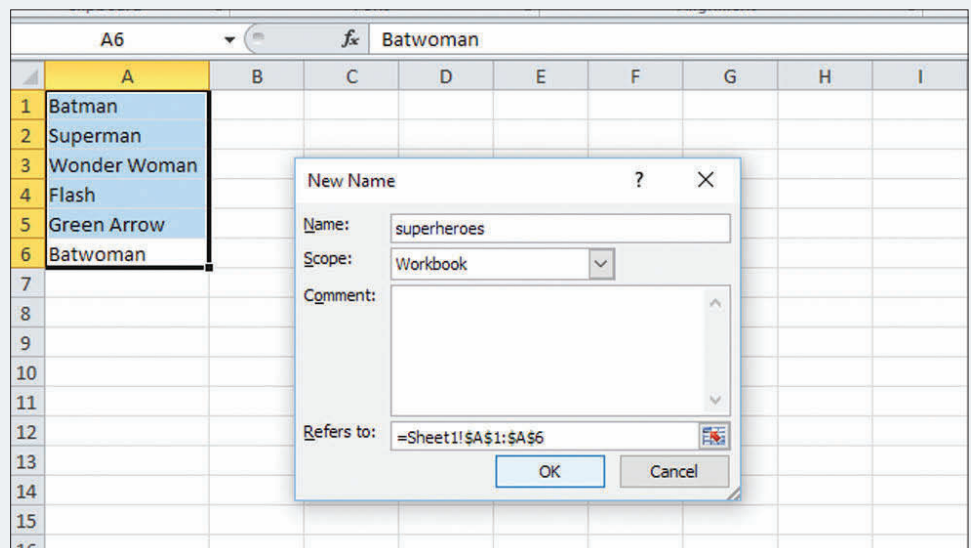
Add down-down list to a spreadsheet

4 Open up an existing, or new, worksheet into which you want to place the drop-down list. Highlight the cell where the list needs to appear, then go up to the menu bar at the top of the page and select Data>Data Validation.
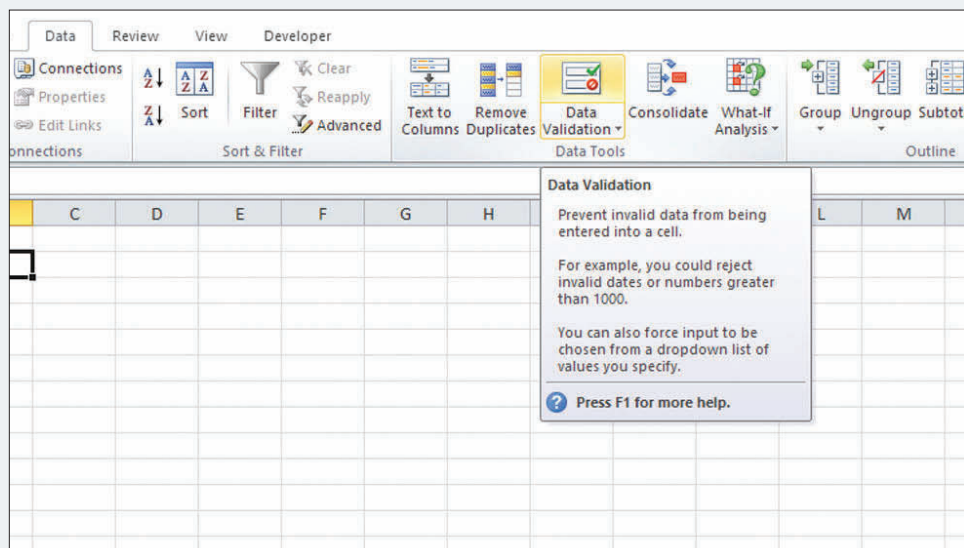
5 In the box that appears you'll see three tabs – Settings, Input Message, and Error Alert – which we'll go through one by one.
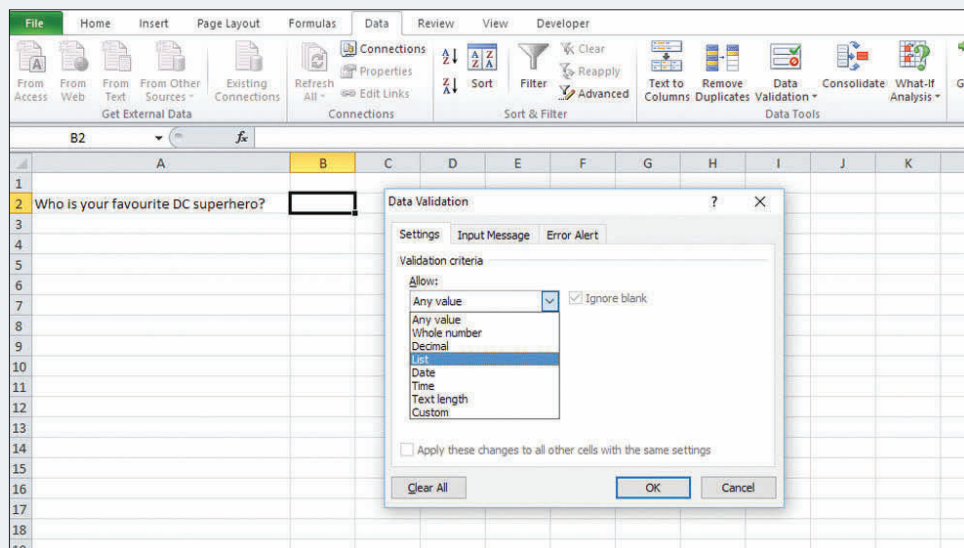
6 The Settings tab will open by default and in here you'll see two drop-down menus. Click on the Allow menu then select List. A new option will now appear at the bottom of the window, entitled Source. Click on this and then enter an '=' sign followed immediately by the name of your list.
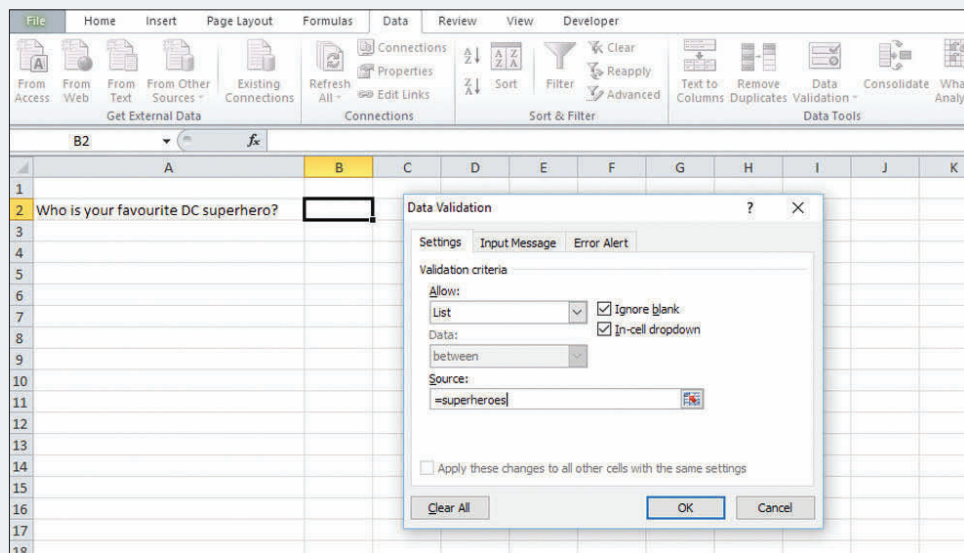
7 Make sure the In-cell drop-down box is ticked and, if you want people to be able to leave the field blank rather than choose from your list, tick the Ignore blank box too.

With that completed you can move onto the Input Message tab, which allows you to create a message that will appear when a user clicks on the drop-down cell. This can be handy if the question you're posing is a complicated one.
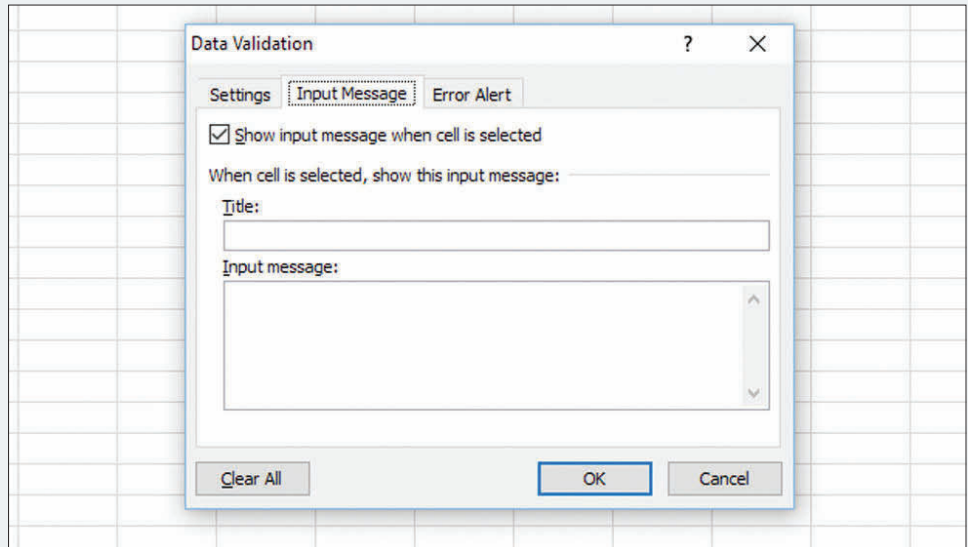
8 Just add a brief title in the relevant field, and then enter the explanation in the main Input message box. If you don't need this feature simply untick the Show input message when cell is selected option at the top.

The last tab is for the Error Alert. This acts in a similar manner to the Input Message, in that it will inform the user if they enter an invalid response. Again you can enter a title and message, but this section also has a setting for Style.
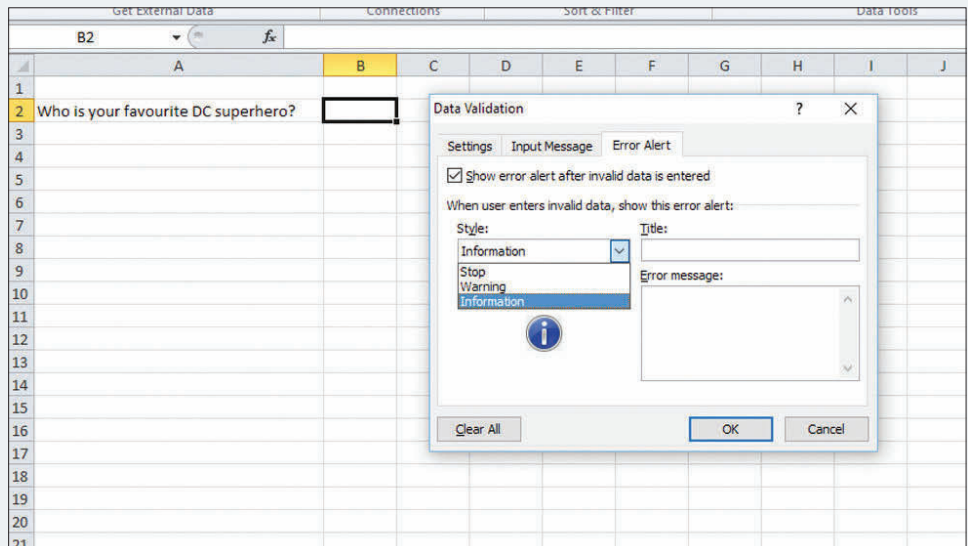
9 Clicking on this will open up three available icons to accompany your message: Stop, Warning and Information. Select the one you feel matches the tone you're after or to dispense with an alert message altogether untick the Show error alert after invalid data is entered box.

Click OK and you will now see an arrow in the cell you selected for the drop-down list. When you click on this your range of answers should appear as if by magic.

That's it. You've added a drop-down list to your worksheet. Now people will be amazed by your advanced Excel-Fu, or they might just select one of the answers from the list. Either way, it's a winner. ⊠
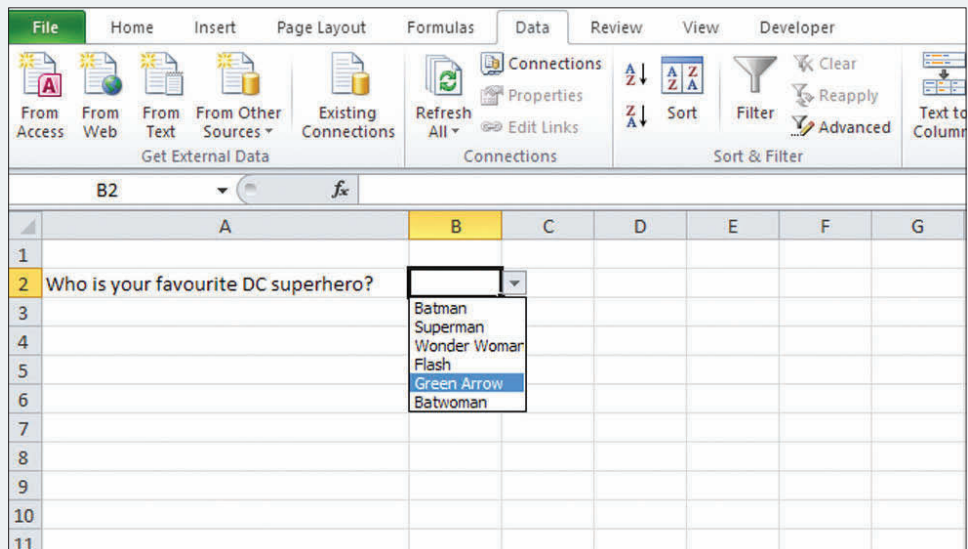
Keep a private store of bookmarks in Chrome

Hush lets you keep some bookmarks that can only be used in incognito mode. Ian Paul shows how

Incognito Mode in Chrome can keep your browsing history secret unless you have a nosy Internet Service Provider, and you're not using a VPN. But one thing incognito doesn't keep secret are any bookmarks you've got. If you've ever wanted to keep a private collection of bookmarks the Chrome extension Hush is one solution.

The extension only works in incognito mode and encrypts your store of private bookmarks that can only be accessed with the password. It's a pretty easy extension to use and can come in handy if you're trying to plan a surprise party on a family computer or just keep some sites to yourself.

START To start using Hush, download and install it from the Chrome Web Store (tinyurl.com/kq2fwwg). Once it's installed, if you click on Hush's lock icon to the right of the address bar, you'll see a note that it only works in incognito mode. For that to happen, however, you have to enable the extension manually. Type **chrome://extensions** into the address bar and hit Enter.

For your privacy, Hush can only be used in an incognito window.

Open incognito window
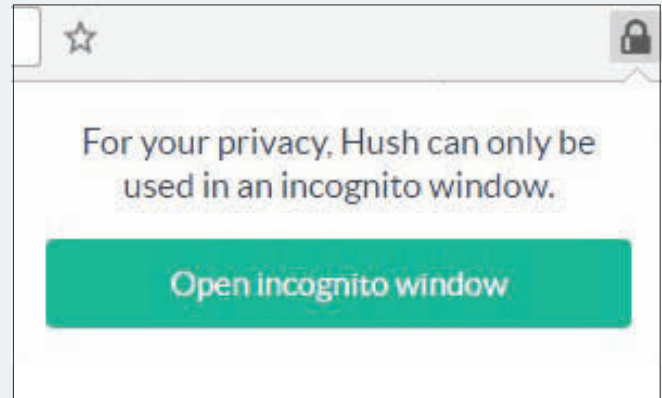
2 Scroll down to Hush's section and check the box labelled Allow in incognito. Chrome will then display a warning explaining that the browser can't prevent an extension from tracking you in incognito mode. For its part, Hush says it never tracks, shares, or stores any of your data aside from the bookmarks you create using the service.

Once you've enabled Hush, click on the icon again and select Open incognito window. An incognito window will then open asking you to enter a password for Hush. Choose whatever password you like, click Load bookmarks, and you're all set.

Hush - private bookmarking   1.1.2   ☑ Enabled 🗑
The only secure way to create and access private bookmarks in incognito mode.
Details
ID: hjmoaenjknbdehbiaeeijcppnljflkff
Inspect views: background page
☑ Allow in incognito
Warning: Google Chrome cannot prevent extensions from recording your browsing history. To disable this extension in incognito mode, unselect this option.

3 To bookmark a site, click on the Hush icon in incognito mode, enter your password, and click Bookmark. To view your saved Hush bookmarks enter your password and click View instead of Bookmark.

If there's one thing we don't like about the service, it's that when you are entering your password to add a bookmark it doesn't obfuscate your password. Instead, it's visible in plain text. That's not great since it means anyone who wanders past your screen at an opportune moment will see your password. Hopefully, that will be fixed in the future. In the meantime, check your six when entering your password.

The service is free to use, but there is a paid option called Hush Pro if you want additional features such as the ability to import regular bookmarks from your browser or sync your Hush bookmarks between devices. Priced $9 (around £7.20) per year, it's available from hushbookmarks.com. ⊠

Enter password...   🔒   Bookmark ▼   View
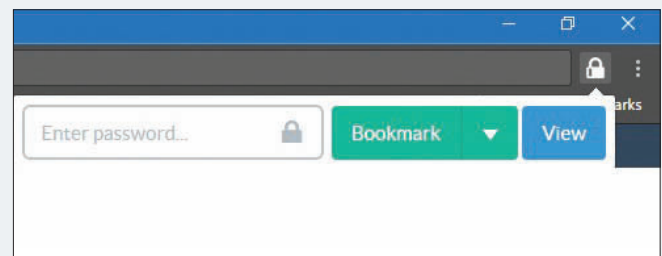
Find friends and family on Facebook

Martyn Casserly reveals some quick ways to find people on the world's most popular social media site

Use Search for Friends

One of the most comprehensive ways to search on Facebook is to use the Search for Friends feature. To access this, open Facebook on your PC and click on the icon of two silhouetted people that you'll see in the upper right corner.

When the drop-down menu appears you'll see the option to Find Friends appear just below where you clicked. Select this and you'll be taken to a new page that lists a number of people Facebook thinks you might know. Obviously it's a good idea to look through this, as Facebook uses its algorithm magic to try and match up users.

On the right side of the page you'll also find the Search for Friends section. This allows you not only to search for someone by name, but also include options for home towns, schools, colleges, universities, mutual friends, and employers.

Just fill in details relevant to the person you're looking to find and hopefully you'll get the right result.
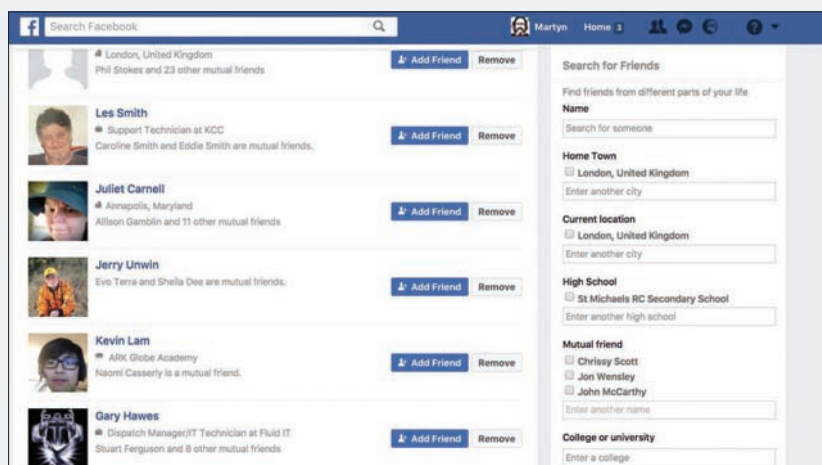
Search for friends of your friends

If the person you're trying to find is also known by some of your other contacts, then look through their friends list to see if they've already tracked them down. To do this, go to the profile of your existing contact and click or tap on the Friends option that's found under their profile picture. Now you'll be able to scroll through all the people they're friends with, and maybe stumble across your old mate.
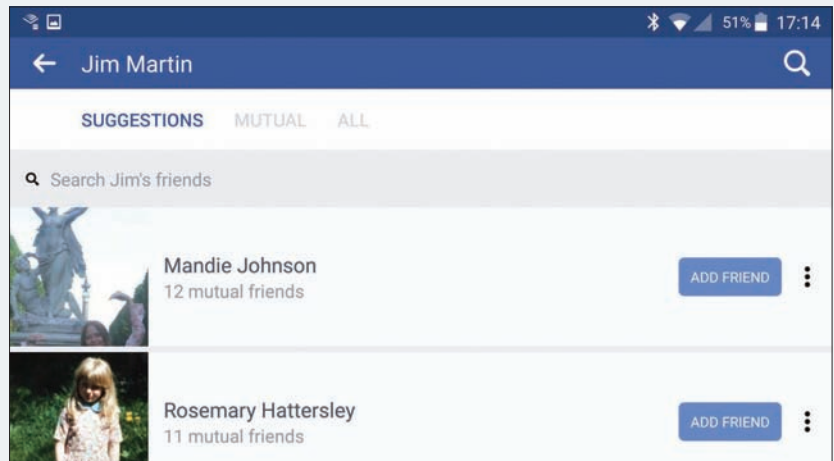
Search old schools and workplaces

When you first sign up to Facebook, and pretty much constantly afterwards, you'll be asked to enter which school, college, university or company you attended/worked at in the past. It's reasonable to assume that the person you're looking for has done the same, so the pages of these organisations are a rich hunting ground.

There's a good chance you might find a group exists, and joining this will put you in touch with plenty of people who might be able to aid you in your quest.
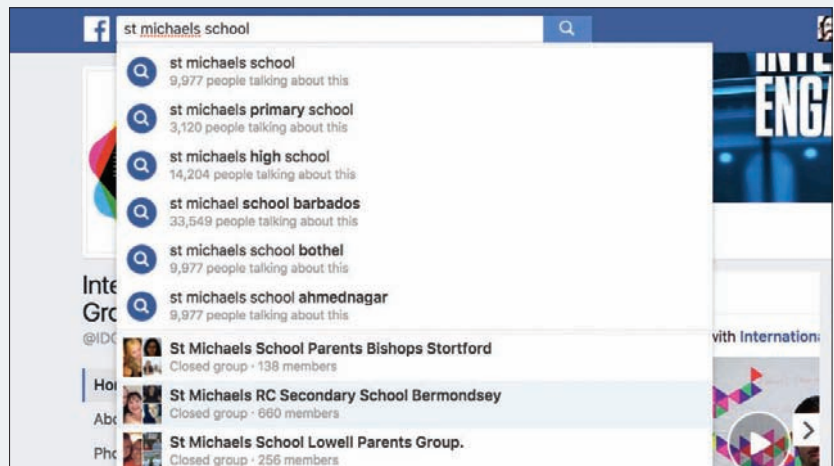
Search your email contacts

If you kept in touch with your absent friend for a while after school or work, then there's a chance you might have exchanged emails at some point. Facebook has a feature where it will search your email addresses and then highlight at any people on the social media platform who are not already connected to you.

To enable this feature, go to the Find Requests section (the silhouette of two people again), click Find Friends, then from the box in the upper right corner entitled Add Personal Contacts, choose which email service you want Facebook to search. Enter your account details, then click the Find Friends button and if you're lucky you might find their name appear. ⊠
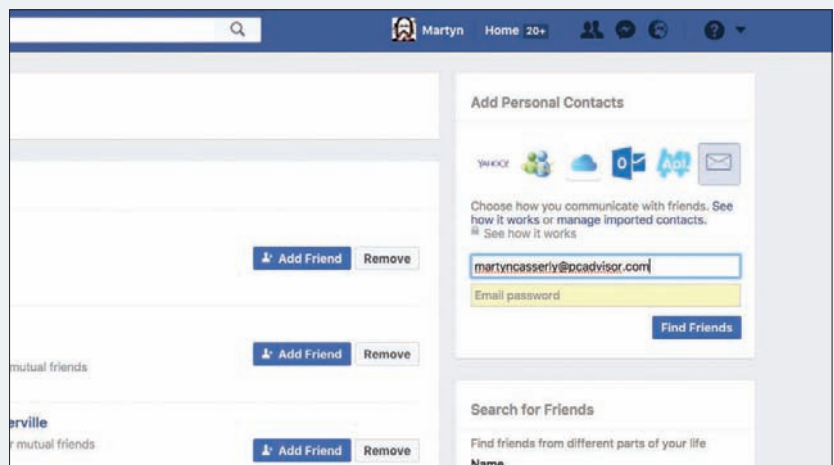
Replace your name on Twitter

If you're embarrassed by an old nickname, Cam Mitchell shows how to change your Twitter name

Mobile

START If you have the Twitter app on your phone, you can change only the name on your profile, not your username. To do so, first open the app, open the side bar by tapping your picture in the top left of the screen and press Profile.
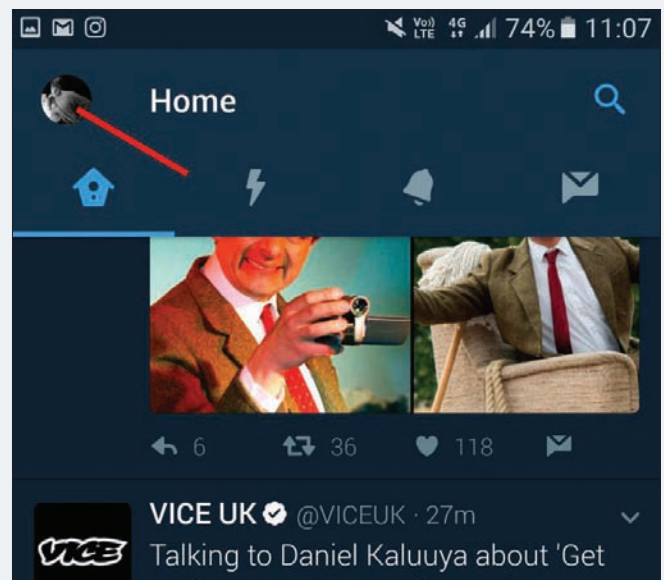
2 Next, press Edit profile – here you will be able to change the name that appears on your profile. Finally, press Save.
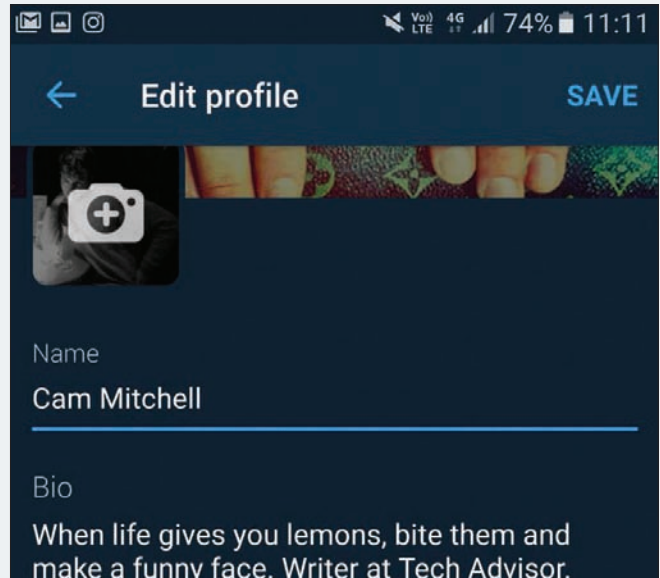
3 If you want to change your username, you will have to log into Twitter through a mobile browser. Next, press your picture in the top left. This will open up the side bar. Once here, press Settings and privacy. Another list will appear and from here tap Username.
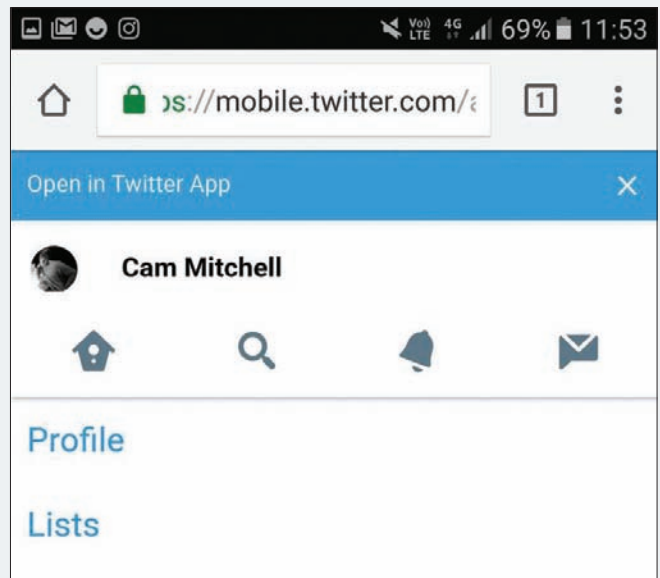
4 Log in and go to your profile. Press Edit Profile and it will open a box underneath your profile photo where you can add your new Twitter name.
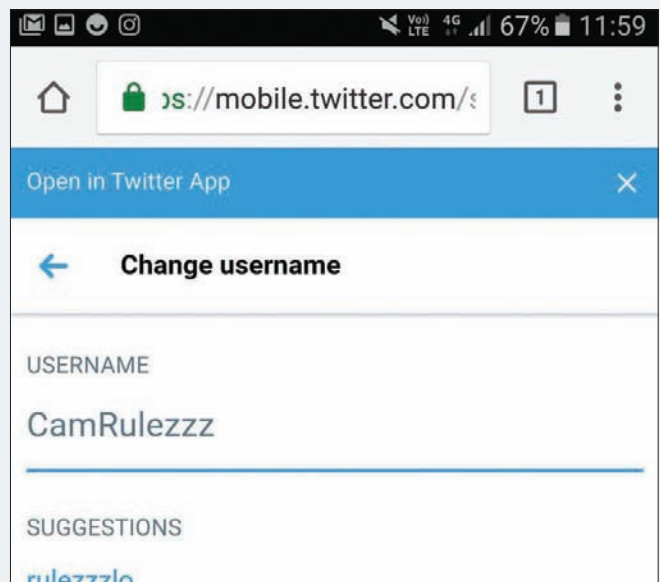
Desktop

5 First, log in to your accounts. Press Edit Profile and it will open a box underneath your profile photo in which you can input your new Twitter name.
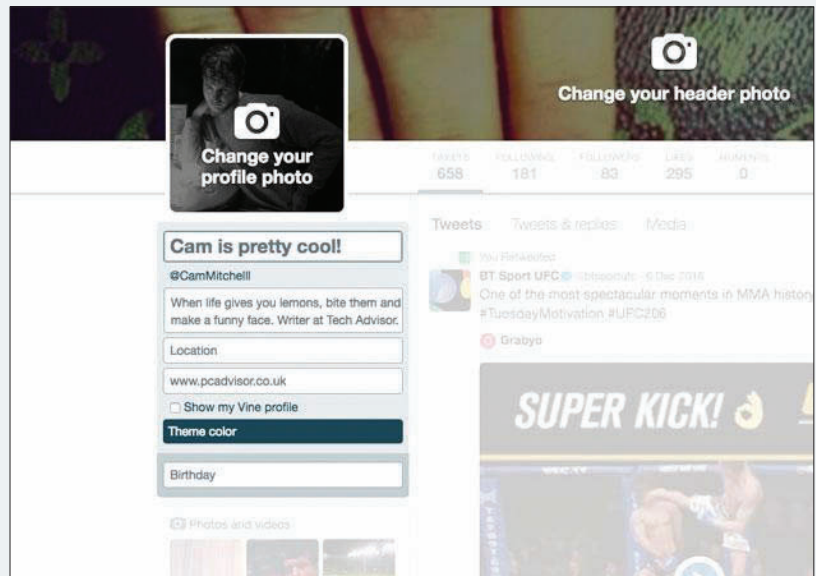
6 To change your Twitter Username, log in to your account. Next, navigate to the small profile icon in the top right next to the blue 'Tweet' button and click it. On the drop-down menu that appears, click Settings and Privacy.
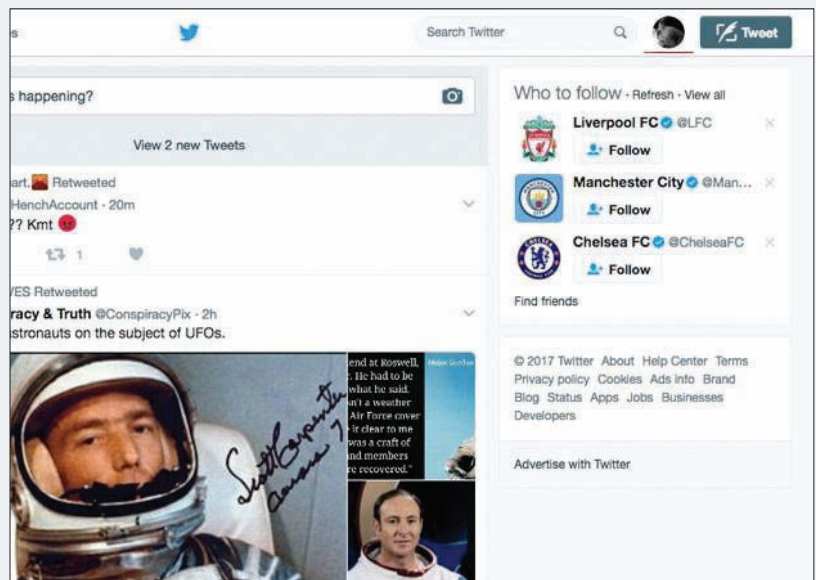
7 At the top of the page is a box in which you can change your username. You can use your new name as part of your Twitter URL to find and share your profile.

So there we have it, you can now play around with your profile and select the perfect username as well as profile name to make your Twitter as personal (or obscure) as you want it to be. ⊠
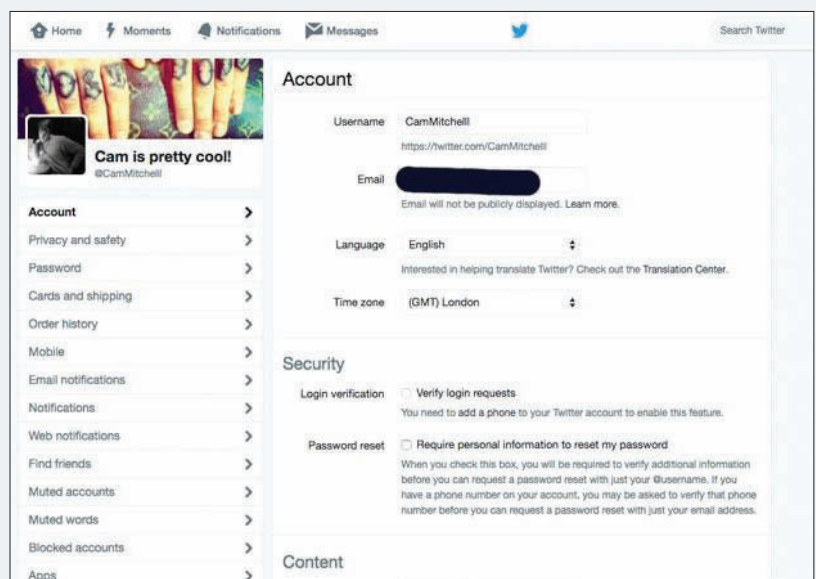
Get more from Google's Gboard keyboard

Translate as you type, call up the numeric keypad whenever you want, and more. Ben Patterson reports

The only problem with Google's Gboard keyboard for Android is that we're totally hooked on its best features. Number and symbol shortcuts above each key? Got to have them. One-handed mode? Ditto. Translate as you type? Love it, need it. Read on for the

niftiest features, from dedicated number rows and an on-demand numeric keypad to 'neural' translations and a long-press shortcut for oft-used symbols. Note, there's also an iOS version, but most of our favourite Gboard tricks only work on the Android edition.

1. Type with one hand

Tapping a virtual keypad with a single thumb can be something of a stretch if your phone has a massive screen. Luckily, Gboard has a clever feature that makes it easier to tap with just one hand.

Tap the little caret sitting in the top-left corner of Gboard, then tap the one-handed mode button (the one that looks like a square with a thumb on top). When you do, the keyboard will squeeze in a bit toward the right side of the screen, making it easier for your thumb to reach every key.

If you'd rather type with your left thumb, tap the arrow on the left side of the keypad, or tap the expand button to turn off one-handed mode.
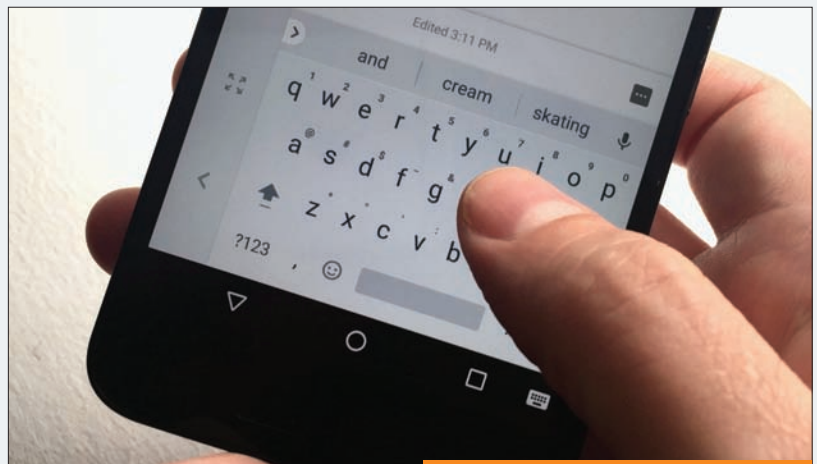
Your thumb will have an easier time stretching across the keyboard if you enable Gboard's one-handed mode

2. Translate as you type

Thanks to its new, sentence-level 'neural machine' translations, Google's translation abilities have morphed from unintentionally hilariously to scary good. In just a few taps, you can compose, email, or even chat in another language, with a respectable degree of fluency.

Again, tap the caret in the top-left corner of Gboard, tap the Google Translate button, pick the language you'd like your words translated into from the drop-down menu on the right, then start typing. Google Translate will work its magic as you type, pasting your translated words directly into whatever document, web page, email or chat window you're using.
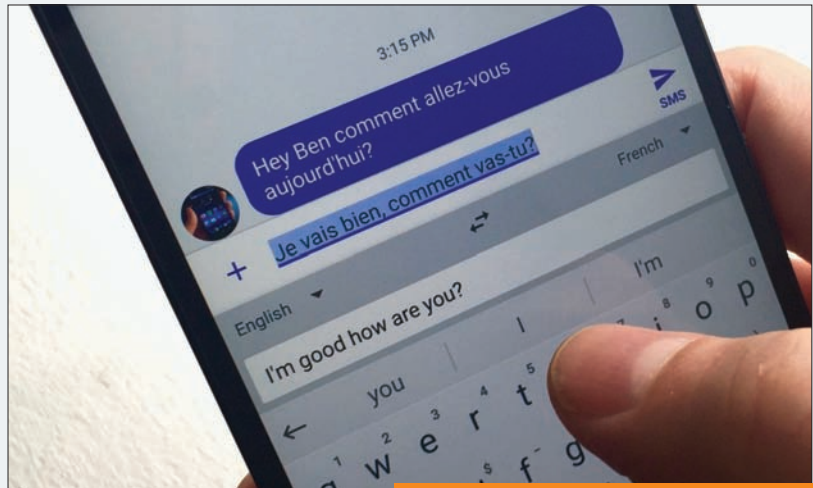
Gboard will translate your words as you type with help from Google Translate's new 'neural' translation abilities

3. Get a dedicated number row

It can get pretty annoying having to tap the symbols button whenever you want to type a number. If you'd rather save yourself a keystroke, there's a time-saving Gboard setting you need to try.

Tap the caret in the corner to reveal the Gboard menu, tap the Settings button, tap Preferences, then toggle on the Number row setting.

Head back to Gboard, and you'll now see a dedicated row of number keys sitting at the top of the keypad, no symbols button required.
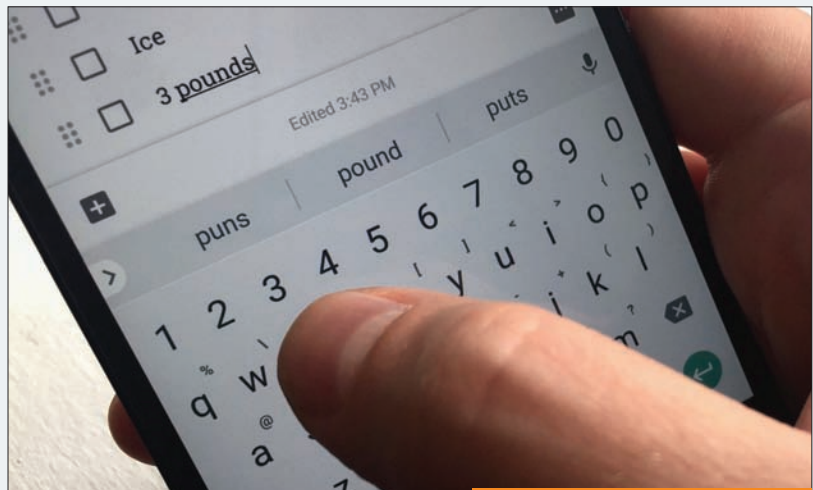
You can get quicker access to the number keys by toggling on Gboard's 'Number row' setting

4. Get the numeric keypad whenever you want

A dedicated row of number keys is nice, but in some case – for example, when you're typing phone or credit card numbers into an online form – a numeric keypad is even better.

Ideally, Gboard should automatically switch on its numeric keypad when you're filling in a numbers-only form. But if you find yourself stuck with the standard keyboard when you just want to type numbers, there's a way to manually enable Gboard's numeric keypad.

First, tap the symbols button in the bottom-left corner of the Gboard keypad. Then, just to the left of the space bar, you'll see a 1 2 3 4 button, with the four numbers arranged two on top of the other. Tap it, and voilà – there's your numeric keypad.
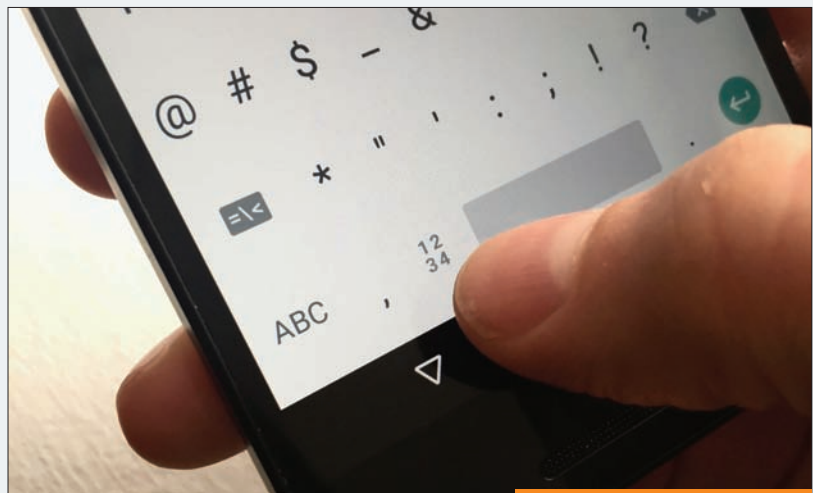
Tap the '1 2 3 4' button to call up Gboard's numeric keypad whenever you want

5. Long-press the full stop key for oft-used symbols

If you need to type a pound sign, a parenthesis, a dash or another common symbol, there's an easier way to do it with Gboard than tapping the symbols key. Tap and hold the full stop key, and you'll get a pop-up with more than a dozen symbols – everything from an ampersand to a question mark. Just slide your fingertip over the symbol you want to type, then release.
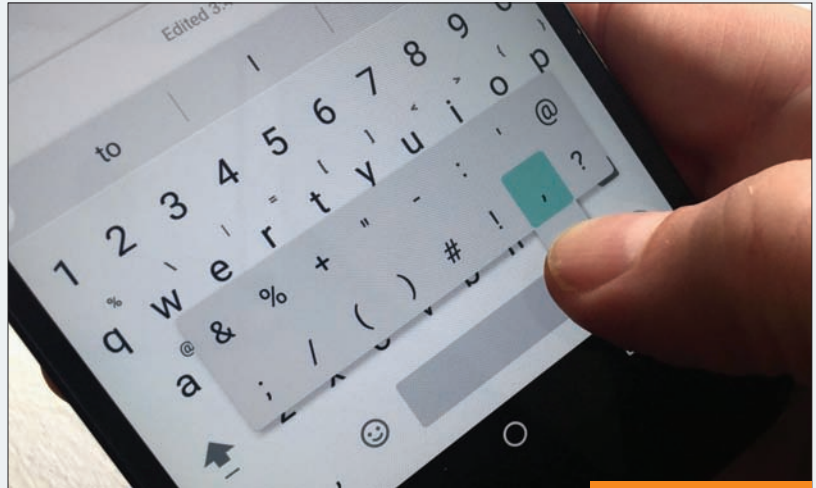
Gboard's most-used symbols are just a long-press away

6. Reveal shortcuts for each key

Head for the Gboard settings screen, tap Preferences, then enable the Long-press for symbols setting. Once you do, you'll see shortcuts for symbols and numbers in the corner of every letter key; just long-press a key to type the shortcut in the corner of the key.
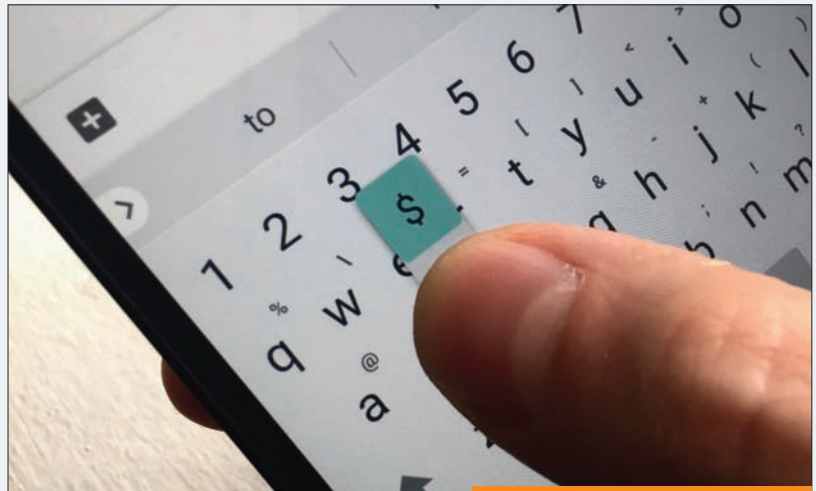
Gboard's 'Long-press for symbols' setting puts shortcuts for symbols on each letter key

7. Move the cursor by swiping the space key

Putting the Android cursor in just the right place can be tricky if you're trying to drag it with your fingertip. Luckily, Gboard boasts a feature that'll let you move the cursor with much more precision.

Just swipe left or right on the Gboard space bar – and as you do, the cursor will move in the corresponding direction, perfect for nudging the cursor exactly where you want it. ⊠
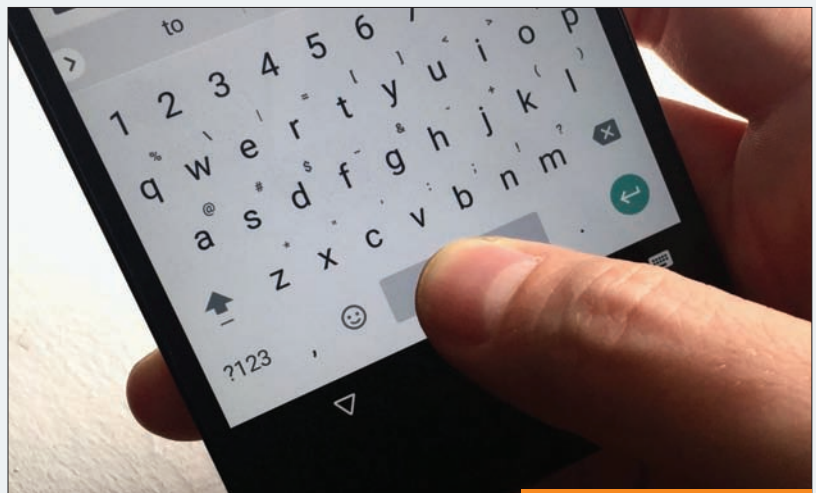
Put the cursor precisely where you want by swiping Gboard's space bar

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PC Advisor's charts rank and rate the best products every month. If you're looking to buy the latest and greatest kit, look no further than our 100-plus reviews

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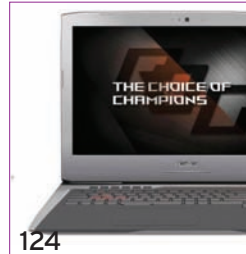
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Prices listed are those quoted by the distributor or manufacturer and include VAT. They are intended only as a guide.

If you're interested in purchasing one of the products reviewed here then please contact the manufacturer or supplier directly, mentioning both *PC Advisor* and the issue in which you saw the product. If it won't supply the product as reviewed, contact us at jim_martin@idg.co.uk.

Manufacturers are under no obligation to feature reviewed products on their websites. Our recommendations are for guidance only.

Star ratings are awarded at the time of the original review and given in relation to the market competition at that time.

Best laptops	1 Dell XPS 13 9360	2 Lenovo Yoga 710 (11in)	3 Asus ZenBook UX310UA	4 Dell Latitude 13 7370	5 HP Envy 13
Price	£999 inc VAT	£549 inc VAT	£699 inc VAT	£1,079 inc VAT	£799 inc VAT
Website	Dell.co.uk	Lenovo.com/uk	Asus.com/uk	Dell.co.uk	Hp.com/uk
Build rating	★★★★★	★★★★½	★★★½☆	★★★★½	★★★☆☆
Features rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★★
Value rating	★★★★½	★★★★½	★★★★★	★★★☆☆	★★★★☆
Performance rating	★★★★½	★★★☆☆	★★★★☆	★★★★☆	★★★★★
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★☆
Processor	2.7GHz Intel Core i7-7500U	Intel Core M3-6Y30	2.3GHz Intel Core i5-6200U	Intel Core m5-6Y57	2.5GHz Intel Core i7
RAM	16GB DDR3	8GB LPDDR3	8GB DDR4	8GB	8GB DDR3
Storage	512GB SSD	128GB SSD	128GB SSD, 500GB HDD	256GB SSD	256GB SSD
Screen size	13.3in IPS	11.6in TN glossy	13.3in LCD	13.3in InfinityEdge	13.3in matt
Screen resolution	3200x1800	1920x1080	3200x1800	1920x1080	1920x1080
Graphics	Intel HD Graphics 620	Intel HD 515	Intel HD 520	Intel HD 515	Intel HD 520
Video memory	N/A	N/A	N/A	N/A	N/A
Wireless	802.11ac	802.11ac	802.11a/b/g/n/ac	802.11ac	802.11a/b/g/n/ac
Ethernet	Gigabit	Gigabit	Gigabit	Gigabit	Gigabit
Bluetooth	✓	✓	✗	✓	✓
USB	2x USB 3.0	1x USB 3.0	1x USB 3.0, 1x USB 2.0	1x USB 3.0, 2x USB-C	3x USB 3.0
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✓	✗	✗	✓	✗
DisplayPort	✗	✗	✗	✗	✓
HDMI	✓	✓	✓	✓	✓
DVI	✗	✗	✗	✗	✗
VGA	✗	✗	✗	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✓	✓	✓
Audio	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic
Optical drive	N/A	N/A	N/A	N/A	N/A
Extras	720p webcam	HD webcam	0.9Mp webcam	HD webcam	HD webcam
Operating system	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Professional	Windows 10 Home
Bundled software	None	None	None	None	None
Gaming scores	Not tested	Not tested	Not tested	Not tested	Not tested
Battery	60Wh	40Wh lithium-ion	48Wh lithium-ion	34Wh	45Wh lithium-ion
Battery life	12 hours 30 mins	9 hrs 45 mins	8 hrs 10 mins	8 hrs 23 mins	1 hr 24 mins
PCMark 8 score	2499	4712	2097	2942	2657
Dimensions	304x200x15mm	281x195x14.9mm	323x223x19mm	304.8x210.5x14.mm	326x226x13mm
Weight	1.3kg	1.04kg	1.45kg	1.12kg	1.3kg
Warranty	1 year	1 year	1 year	1 year	1-year collect-and-return
FULL REVIEW	TINYURL.COM/ZCTTZLO	TINYURL.COM/ZSVR34C	TINYURL.COM/ZYLAEF8	TINYURL.COM/HDHYG2P	TINYURL.COM/HDAQHQX

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Best laptops	Acer S 13 S5-371	Microsoft Surface Book	Apple MacBook (2016)	HP Spectre 13	Apple MacBook Pro (2016)
		7	**8**	**9**	**10**
Price	£549 inc VAT	£1,299 inc VAT	£1,049 inc VAT	£1,299 inc VAT	£1,4949 inc VAT
Website	Acer.com/uk	Microsoft.com/en-gb	Apple.com/uk	Hp.com/uk	Apple.com/uk
Build rating	★★★★☆	★★★★½	★★★★☆	★★★★½	★★★★☆
Features rating	★★★★½	★★★★½	★★★★☆	★★★☆☆	★★★★☆
Value rating	★★★★★	★★★★☆	★★★★☆	★★★☆☆	★★★★☆
Performance rating	★★★★☆	★★★★½	★★★★☆	★★★★☆	★★★★☆
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★★☆
Processor	2.3GHz Intel Core i3-6100U	Intel Core i5	1.1GHz Intel Core m3	2.5GHz Intel Core i7-6500U	2GHz Intel Core i5
RAM	8GB LPDDR3	8GB	8GB LPDDR3	8GB DDR3	8GB LPDDR3
Storage	128GB SSD	128GB SSD	256GB SSD	512GB SSD	256GB SSD
Screen size	13.3in IPS	13.5in PixelSense	12in IPS	13.3in IPS	13.3in IPS
Screen resolution	1920x1080	3000x2000	2304x1440	1920x1080	1680x1050
Graphics	Intel HD Graphics 520	Intel HD Graphics 520	Intel HD Graphics 515	Intel HD 520	Intel Iris Graphics 540
Video memory	N/A	N/A	N/A	N/A	N/A
Wireless	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11ac	802.11ac	802.11a/b/g/n/ac
Ethernet	✗	✗	✗	✗	Gigabit
Bluetooth	✓	✓	✓	✓	✓
USB	2x USB 3.0	2x USB 3.0	1x USB-C	1x USB-C	1x USB-C
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✗	✗	✗	✓	✗
DisplayPort	✗	✓	✗	✗	✗
HDMI	✓	✗	✗	✗	✗
DVI	✗	✗	✗	✗	✗
VGA	✗	✗	✗	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✗	✗	✗
Audio	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic
Optical drive	N/A	N/A	N/A	N/A	N/A
Extras	HD Webcam	Surface Pen	480p FaceTime	Webcam	720p webcam
Operating system	Windows 10	Windows 10 Professional	macOS Sierra	Windows 10	macOS Sierra
Bundled software	None	None	None	None	None
Gaming scores	27.6/12.3fps Alien Isolation	Not tested	Not tested	Not tested	Not tested
Battery	4030mAh lithium-ion	Not stated	41.4Wh lithium-polymer	38Wh lithium-polymer	54.5Wh lithium-polymer
Battery life	10 hours	12 hours	8 hrs 23 mins	8 hrs 55 mins	10 hrs
PCMark 8 score	2040	Not tested	Not tested	2735	Not tested
Dimensions	327x287x15mm	312.3x232.11x3mm	280.5x196.5x35mm	325x229x10.4mm	304x212x14mm
Weight	1.33kg	1.52kg	920g	1.1kg	1.37kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZAU8QLM	TINYURL.COM/ZZF4ZQ2	TINYURL.COM/HSSXYUJ	TINYURL.COM/HSXM7SH	TINYURL.COM/ZTX4LC3

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Best budget laptops	1 HP 250 G4	2 Dell Inspiron 11 3000	3 Asus X555LA	4 Chuwi LapBook 14.1	5 HP Stream 11
Price	£299 inc VAT	£179 inc VAT	£349 inc VAT	£224 inc VAT	£179 inc VAT
Website	Hp.com/uk	Dell.co.uk	Asus.com/uk	En.chuwi.com	Hp.com/uk
Build rating	★★★★☆	★★★★☆	★★★½☆	★★★½☆	★★★½☆
Features rating	★★★★☆	★★★★☆	★★★½☆	★★★½☆	★★★½☆
Value rating	★★★★☆	★★★★★	★★★★☆	★★★★★	★★★½☆
Performance rating	★★★★☆	★★☆☆☆	★★★½☆	★★★½☆	★★★★½
Overall rating	★★★★★	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Processor	2.1GHz Intel Core i5-5005U	1.6-2.1GHz Intel Celeron N3050	2GHz Intel Core i3-5005U	Intel Celeron N3450	2.16GHz Intel Celeron
RAM	8GB	2GB	4GB DDR3	4GB DDR3L	2GB DDR3
Storage	1TB HDD	32GB SSD	1TB HDD	64GB eMMc drive	32GB eMMc drive
Screen size	15.6in matt	11.6in matt	15.6in glossy	14.1in matt	11.6in matt
Screen resolution	1366x768	1366x768	1366x768	1920x1080	1366x768
Graphics	Intel HD GPU	Intel HD	Intel HD Graphics 5500	Intel Graphics 5000	Intel HD Graphics
Video memory	N/A	N/A	N/A	N/A	N/A
Wireless	802.11b/g/n	802.11a/b/g/n	802.11b/g/n	802.11b/g/n/ac	802.11b/g/n
Ethernet	Gigabit	✗	Gigabit	✗	✗
Bluetooth	✓	✓	✓	✓	✓
USB	1x USB 3.0, 2x USB 2.0	1x USB 3.0, 1x USB 2.0	1x USB 3.0, 2x USB 2.0	1x USB 3.0, 1x USB 2.0	1x USB 3.0, 1x USB 2.0
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✗	✗	✗	✗	✗
DisplayPort	✗	✗	✗	✗	✗
HDMI	✓	✓	✓	✓	✓
DVI	✗	✗	✗	✗	✗
VGA	✓	✗	✓	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✗	✓	✓
Audio	Headphone minijack	Headphone minijack	Headphone minijack	Headphone minijack	Headphone minijack
Optical drive	DVD±RW	✗	DVD±RW	✗	✗
Extras	Webcam	Webcam	Kensington lock slot, webcam	Webcam	Kensington lock slot, webcam
Operating system	Windows 10	Windows 8	Windows 8.1	Windows 10 Home	Windows 8.1
Bundled software	None	None	None	None	None
Battery	31Wh Lithium-ion	32Wh Lithium-polymer	37Wh Lithium-ion	9000mAh Lithium-polymer	37Wh Lithium-polymer
Battery life	5 hrs 5 mins	8 hrs 15 mins	5 hrs 17 mins	4 hrs	8 hrs 45 mins
PCMark 8 Home score	2171	Not tested	1985	3664	Not tested
Batman (Low/High)	Not tested	Not tested	30fps/Not tested	Not tested	Not tested
Dimensions	384x254x24mm	292x196x19.9mm	381x257x26.3mm	329.2x220.5x20.5mm	300x205x20mm
Weight	2.1kg	1.39kg	2.1kg	1.5kg	1.25kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/Z5XNZOR	TINYURL.COM/Z3AUEFY	TINYURL.COM/OMYZQJ3	TINYURL.COM/ZKWN33K	TINYURL.COM/GNRP9BC

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Best budget laptops	6 Asus X553SA	7 Chuwi HiBook Pro	8 Asus VivoBook Max X541SA	9 Lenovo Yoga 300	10 Chuwi Hi10 Pro
Price	£279 inc VAT	£172 inc VAT	£299 inc VAT	£299 inc VAT	£128 inc VAT
Website	Asus.com/uk	En.chuwi.com	Asus.com/uk	Lenovo.com/uk	En.chuwi.com
Build rating	★★★½☆	★★★★☆	★★★☆☆	★★★★☆	★★★★☆
Features rating	★★★★½	★★★½☆	★★★½☆	★★★★☆	★★★½☆
Value rating	★★★½☆	★★★★½	★★★★☆	★★½☆☆	★★★★½
Performance rating	★★☆☆☆	★★★½☆	★★★½☆	★★½☆☆	★★★½☆
Overall rating	★★★★½	★★★★☆	★★★☆☆	★★★★☆	★★★★☆
Processor	2.1GHz Intel Core Celeron	1.84GHz Intel Atom X5	1.6GHz Intel Pentium N3710	2.16GHz Intel Pentium N3700	1.44GHz Intel Atom X5
RAM	8GB DDR3	4GB DDR3	4GB DDR3	4GB DDR	4GB
Storage	500GB	64GB	1TB	500GB	64GB
Screen size	15.6in glossy	10.1in matt IPS	15.6in IPS	11.6in IPS	10.1in full-HD
Screen resolution	1366x768	2560x1600	1366x768	1366x768	1920x1200
Graphics	Intel HD	Intel HD Graphics	Intel HD 405	Intel HD Graphics	Intel HD Graphics
Video memory	N/A	N/A	N/A	N/A	N/A
Wireless	802.11a/b/g/n/ac	802.11b/g/n	802.11b/g/n	802.11ac	802.11b/g/n
Ethernet	Gigabit	Gigabit	Gigabit	Gigabit	Gigabit
Bluetooth	✓	✓	✓	✓	✓
USB	1x USB 3.0, 1x USB 2.0	1x USB-C	1x USB-C, 1x USB 2.0, 1x USB 3.0	1x USB 3.0, 2x USB 2.0	1x USB-C, 1x Micro-USB
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✗	✗	✗	✗	✗
DisplayPort	✗	✗	✗	✗	✗
HDMI	✓	✓	✓	✓	✓
DVI	✗	✗	✗	✗	✗
VGA	✗	✗	✗	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✓	✓	✓
Audio	Headphone jack, mic	Headphone jack, mic	Headphone minijack	Headphone jack, mic	Headphone minijack
Optical drive	Super-Multi DVD	✗	✗	N/A	✗
Extras	VGA webcam	720p webcam	HD webcam	None	2Mp/2Mp front and rear cameras
Operating system	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10/Android 5.1
Bundled software	None	None	None	None	None
Battery	48Wh lithium-ion	8000mAh	36Wh lithium-ion	48Wh lithium-ion	6500mAh
Battery life	4 hrs 35 mins	Not tested	3 hrs 57 mins	6 hrs 34 mins	8 hrs
PCMark 8 Home score	Not tested	940	Not tested	1457	1041
Batman (Low/High)	Not tested	Not tested	Not tested	Not tested	Not tested
Dimensions	380x258x25.3mm	262x167.5x8.5mm	381x252x27.6mm	299x209x22mm	261.8x167.3x8.5mm (battery)
Weight	2.2kg	550g	2kg	1.39kg	562g (battery); 545g (keyboard)
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZLN2DVF	TINYURL.COM/JVYEQYV	TINYURL.COM/H3HC4Q8	TINYURL.COM/HRXVJXT	TINYURL.COM/J7F5URW

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Best Chromebooks	**1** Dell Chromebook 11 (3120)	**2** Asus Chromebook Flip C100PA	**3** Acer Chromebook 14
Price	**£202 inc VAT**	**£249 inc VAT**	**£199 inc VAT**
Website	Dell.co.uk	UK.asus.com	Acer.co.uk
Build rating	★★★★½	★★★★½	★★★½☆
Features rating	★★★★☆	★★★★☆	★★★☆☆
Value rating	★★★★☆	★★★★☆	★★★½☆
Performance rating	★★★★☆	★★★★☆	★★★½☆
Overall rating	★★★★☆	★★★★☆	★★★½☆
Processor	2.16GHz Intel Celeron N2840	1.86GHz Rockchip RK3288C	1.6GHz Intel Celeron N3060
RAM	4GB DDR3	4GB DDR3	2GB
Storage	16GB SSD	16GB SSD	16GB eMMC
Screen size	11.6in HD	10.1in	14in LCD
Screen resolution	1366x768	1280x800	1366x768
Graphics	Intel HD graphics	Rockchip Mali T764	Intel HD graphics
Video memory	N/A	N/A	N/A
Wireless	802.11a/b/g/n	802.11a/b/g/n/ac	802.11a/b/g/n/ac
Ethernet	Gigabit	Gigabit	Gigabit
Bluetooth	✓	✓	✓
USB	1x USB 3.0, 1x USB 2.0	2x USB 2.0	2x USB 3.0
FireWire	✗	✗	✗
Thunderbolt	✗	✗	✗
DisplayPort	✗	✗	✗
HDMI	✓	✓	✓
DVI	✗	✗	✗
VGA	✗	✗	✗
eSATA	✗	✗	✗
Media card slot	✓	✓	✓
Audio	Headphone minijack	Headphone minijack	Headphone minijack
Optical drive	N/A	N/A	N/A
Extras	Webcam	Webcam	HD webcam
Operating system	Google Chrome OS	Google Chrome OS	Google Chrome OS
Bundled software	None	None	None
Battery life	9 hrs 46 mins	9 hrs 33 mins	11 hrs 13mins
SunSpider score	697ms	803ms	638ms
Dimensions	297x217.7x120.1mm	262.8x182.4x15.6mm	340x236x17mm
Weight	1.25kg	890g	1.6kg
Warranty	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZQFP4MF	TINYURL.COM/J9CU5YH	TINYURL.COM/HH8OOT4

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Best Chromebooks	**4** Acer Chromebook R11	**5** HP Chromebook 11	**6** Asus C300M
Price	**£229 inc VAT**	**£229 inc VAT**	**£250 inc VAT**
Website	Acer.co.uk	Hp.com/uk	UK.asus.com
Build rating	★★★½☆	★★★☆☆	★★★½☆
Features rating	★★★½☆	★★★☆☆	★★★★☆
Value rating	★★★½☆	★★★½☆	★★★★☆
Performance rating	★★★½☆	★★☆☆☆	★★★½☆
Overall rating	★★★½☆	★★★☆☆	★★★★☆
Processor	1.6GHz Intel Celeron N3050	1.7GHz Exynos 5250	Intel Celeron N2830
RAM	2GB DDR3	2GB DDR3	2GB DDR3
Storage	16GB SSD	16GB	16GB SSD
Screen size	11in IPS	11.6in IPS	13.3in
Screen resolution	1366x768	1366x768	1366x768
Graphics	Intel HD graphics	Intel HD graphics	Intel HD graphics
Video memory	N/A	N/A	N/A
Wireless	802.11a/b/g/n/ac	802.11a/b/g/n	802.11a/b/g/n
Ethernet	Gigabit	None	Gigabit
Bluetooth	✓	✓	✓
USB	4x USB 3.0, 1x USB 2.0	2x USB 2.0	1x USB 3.0, 1x USB 2.0
FireWire	✗	✗	✗
Thunderbolt	✗	✗	✗
DisplayPort	✗	✗	✗
HDMI	✓	✗	✓
DVI	✗	✗	✗
VGA	✗	✗	✗
eSATA	✗	✗	✗
Media card slot	✓	✗	✓
Audio	Headphone minijack	Headphone minijack	Headphone minijack
Optical drive	N/A	N/A	N/A
Extras	Webcam	Webcam	720p webcam
Operating system	Google Chrome OS	Google Chrome OS	Google Chrome OS
Bundled software	None	None	None
Battery life	9 hrs 30 mins	5 hrs	9 hrs 28 mins
SunSpider score	Not tested	Not tested	Not tested
Dimensions	19.2x294x204mm	297x195x17.4mm	339x230x20.3mm
Weight	1.25kg	1.03kg	1.4kg
Warranty	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/GOVMT3X	TINYURL.COM/HB3JEBG	TINYURL.COM/HW86CWG

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Best gaming laptops	**1** Asus RoG G752VM	**2** Alienware 17	**3** MSI GL62-6QC 065UK	**4** Asus RoG GL552VW-DM201T	**5** Dell Inspiron 15 7559
Price	£1,599 inc VAT	£1,350 inc VAT	£599 inc VAT	£899 inc VAT	£999 inc VAT
Website	Asus.com/uk	Alienware.co.uk	Asus.com/uk	Asus.com/uk	Dell.co.uk
Build rating	★★★★★	★★★★½	★★★★☆	★★★½☆	★★★★☆
Features rating	★★★★★	★★★★★	★★★★☆	★★★½☆	★★★★☆
Value rating	★★★★☆	★★★½☆	★★★½☆	★★★½☆	★★★★☆
Performance rating	★★★★★	★★★★★	★★★½☆	★★★★☆	★★★★☆
Overall rating	★★★★½	★★★★½	★★★½☆	★★★½☆	★★★★☆
Processor	2.6GHz Intel Core i7-6700HQ	4.1GHz Intel Core i7-6820	2.3GHz Intel Core i5-6300HQ	2.6GHz Intel Core i7-6700HQ	2.6GHz Intel Core i7-6700HQ
RAM	16GB DDR4-2400	8GB DDR5, 16GB DDR4	8GB DDR3L	8GB DDR3	16GB DDR3L RAM
Storage	256GB SSD, 1TB HDD	512GB SSD, 1TB HDD	1TB HDD	1TB HDD	128GB SSD, 1TB HDD
Screen size	17.3in IPS	17.3in IPS	15.6in IPS	15.6in IPS	13.6in IPS
Screen resolution	1920x1080	1920x1080	1920x1080	1920x1080	3840x2160
Graphics	Nvidia GeForce GTX 1060	Nvidia GeForce GTX 980M	Nvidia GeForce 940MX	Nvidia GeForce GTX 960M	nVidia GeForce GTX 960M
Video memory	Not specified	Not specified	Not specified	Not specified	N/A
Wireless	802.11ac	802.11ac	802.11ac	802.11ac	802.11ac 1x1 MIMO
Ethernet	Gigabit	Gigabit	Gigabit	Gigabit	Gigabit
Bluetooth	✓	✓	✓	✓	✓
USB	4x USB 3.0, 1x USB-C	3x USB 3.0, 1x USB-C	2x USB 3.0, 1x USB-C	2x USB 3.0, 1x USB 3.0	3x USB 3.0
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✗	✓	✗	✗	✗
DisplayPort	✓	✗	✓	✗	✗
HDMI	✓	✓	✓	✓	✓
DVI	✗	✗	✗	✗	✗
VGA	✗	✗	✗	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✓	✓	✓
Audio	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic
Optical drive	✓	None	✓	None	N/A
Extras	1.2Mp webcam	2Mp webcam	HD webcam	HD webcam	0.9Mp webcam
Operating system	Windows 10	Windows 10 Home	Windows 10	Windows 10	Windows 10 Home
Bundled software	None	None	None	None	None
Gaming scores	Not tested	Not tested	Not tested	Not tested	34/27fps in Tomb Raider
Battery	67Wh lithium-ion	31Wh lithium-polymer	41Wh lithium-ion	48Wh lithium-polymer	74Wh lithium-ion
Battery life	4 hrs	3 hrs 59 mins	3rs 55 mins	4 hrs 50 mins	5 hrs 27 mins
PCMark 8 score	Not tested	3400	Not tested	3102	Not tested
Dimensions	428x334x43mm	430x292x34.4mm	383x260x27mm	384x257x34.5mm	383x265x26.1mm
Weight	4.1kg	3.8kg	2.3kg	2.6kg	2.8kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/H23QHCQ	TINYURL.COM/JYK953S	TINYURL.COM/JAXBRDB	TINYURL.COM/HQKNNRJ	TINYURL.COM/ZZV3JQZ

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Best gaming PCs	1 Wired2Fire Diablo Fury	2 Yoyotech Warbird RS10 V2	3 Chillblast Fusion Tracer RX 480	4 Overclockers UK Kinetic HR	5 Mesh Storm PCA
Price	£914 inc VAT	£824 inc VAT	£749 inc VAT	£660 inc VAT	£699 inc VAT
Website	Wired2fire.co.uk	Yoyotech.co.uk	Chillblast.com	Overclockers.co.uk	Meshcomputers.com
Build rating	★★★★★	★★★★½	★★★★☆	★★★★☆	★★★★☆
Features rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★☆☆
Value rating	★★★★★	★★★★★	★★★★☆	★★★★★	★★★★½
Performance rating	★★★★☆	★★★★☆	★★★★½	★★★½☆	★★★★☆
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★★☆
Processor	3.5GHz Intel Core i5-6600K (OC 4.4GHz)	3.5GHz Intel i5-6600K (OC 4.6GHz)	2.8- to 3.4GHz Intel Core i5-6420P	3.7GHz Intel Core i3-6100	3.2GHz Intel Core i5-6500 (3.6GHz Turbo)
CPU cooler	ID Cooling SE-214X	Coolermaster Hyper 212 EVO	Intel Stock Cooler	Stock cooler	BeQuiet Pure Rock Slim Compact
Memory	16GB DDR4	8GB DDR4	8GB DDR	8GB DDR4	8GB DDR4
Storage	250GB SSD	1TB HDD	1TB HDD, 250GB SSD	1TB SSHD	1TB HDD
Power supply	500W FSP	500W Evga 80Plus	500W PSU	500W Kolink	500W Aerocool Quiet
Motherboard	Asus Z170-P	MSI Z170-A Pro	Gigabyte GA-H110M-S2H	Asus H110M-K mATX	Asus B150M Pro Gaming
Operating system	Windows 10 Home (64-bit)	Windows 10 (64-bit)	Windows 10 Home	Windows 10 (64-bit)	Windows 10 Home (64-bit)
Screen	None supplied	None supplied	None supplied	None supplied	None supplied
Graphics	Nvidia GeForce GTX 1060	Nvidia GeForce GTX 1060	AMD Radeon RX 480	Sapphire Nitro+ OC RX470	GeForce GTX 1060
Sound	Onboard	Onboard	Onboard	Onboard	Onboard
Connectivity	Gigabit ethernet	Gigabit ethernet	Gigabit ethernet	Gigabit ethernet	Gigabit ethernet
Ports	4x USB 3.0, 2x USB 2.0, 1x USB Type-C, 2x DVI, HDMI, DisplayPort, eSATA	5x USB 3.0, 3x USB 2.0, 2x DisplayPort, 2x HDMI, DVI	3x USB 3.0, 6x USB 2.0, 2x PS/2, DisplayPort, DVI, HDMI	3x USB 3.0, 5x USB 2.0. VGA: 2x HDMI, 2x DisplayPort, DVI. Motherboard: DVI-D, VGA	5x USB 3.0, 5x USB 2.0, line in, line out, PS/2, 10/100/1000 (LAN)
Optical drive	None	None	None	None	None
Case	NZXT Source 340	Aerocool Aero-500	CiT F3 Black and Red	Kolink Victory Micro-ATX Gaming Dase	CiT Storm Black ATX
Keyboard & mouse	None supplied	None supplied	None supplied	None supplied	✓
PCMark 8 2.0 Home score	5200	4686	3984	4048	4158
Alien Isolation score (4K)	17.02/49.28fps	48.7/59.1fps	45.1/52.7fps	42.6/50.8fps	46.5/56.9fps
Thief (4K High)	32.4/38.9fps	31.7/38.2fps	32.3/40.1fps	30.7/37.4fps	24.9/35.7fps
Thief (1080p Ultra)	72.1/89.1fps	48.3/81.7fps	48.8/70.3fps	32.4/65.3fps	32.6/67.8fps
VRMark Orange	7063	6993	6934	5812	6356
Power Consumption	46.5/263	52.6/249W	53/297W	37/308W	38/215W
Warranty	2 years C&R, 1 year return to labour	3 years RTB (1 year parts & labour, 2 years labour)	3 years C&R, 5 years labour only, lifetime phone	2 years parts & labour C&R, 1 year RTB labour only	Lifetime labour, 2-year parts, 1 year free C&R
FULL REVIEW	TINYURL.COM/JSJLOPV	TINYURL.COM/ZZLFK56	TINYURL.COM/GRASZCO	TINYURL.COM/ZR2EGFB	TINYURL.COM/ZUYDBHD

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Best smartphones	1 Samsung Galaxy S7 edge	2 Samsung Galaxy S7	3 LG G5	4 Apple iPhone 7	5 OnePlus 3T
Price	£639 inc VAT	£569 inc VAT	£529 inc VAT	£599 inc VAT	£399 inc VAT
Website	Samsung.com/uk	Samsung.com/uk	LG.com/uk	Apple.com/uk	Oneplus.net
Build rating	★★★★½	★★★★½	★★★★☆	★★★★½	★★★★½
Features rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★½
Value rating	★★★★☆	★★★★½	★★★★½	★★★½☆	★★★★½
Performance rating	★★★★★	★★★★★	★★★★½	★★★★½	★★★★½
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★½
OS (out of box)	Android 6.0 Marshmallow	Android 6.0 Marshmallow	Android 6.0 Marshmallow	iOS 10	Android 6.0.1 Marshmallow
Processor	Qualcomm Snapdragon 820	Qualcomm Snapdragon 820	Qualcomm Snapdragon 820	A10 Fusion	Qualcomm Snapdragon 821
RAM	4GB	4GB	4GB	2GB	6GB
Storage	32GB	32GB	32GB	32/128/256GB	64/128GB
MicroSD support	✓	✓	✓	✗	✗
Graphics	Adreno 530	Adreno 530	Adreno 530	Not stated	Adreno 530
Screen size	5.5in	5.1in	5.3in	4.7in	5.5in
Screen resolution	2560x1440	2560x1440	2560x1440	1334x720	1920x1080
Pixel density	534ppi	577ppi	554ppi	326ppi	401ppi
Screen technology	IPS	IPS	IPS	IPS	AMOLED
Front camera	5Mp	5Mp	8Mp	7Mp	16Mp
Rear camera	16Mp, LED flash	12Mp, LED flash	8/16Mp, LED flash	12Mp, LED flash	16Mp, LED flash
Video recording	4K	4K	4K	4K	4K
Cellular connectivity	4G	4G	4G	4G	4G
SIM type	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✗
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2
GPS	GPS, Glonass	A-GPS, Glonass	A-GPS	A-GPS, Glonass	A-GPS, Glonass
NFC	✓	✓	✓	✓	✓
USB OTG	✓	✓	✓	✓	✓
Extra features	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner
Geekbench 4.0 (multi)	6469 (Geekbench 3.0)	6466 (Geekbench 3.0)	5404 (Geekbench 3.0)	6088	4257
JetStream	66.1	61	53.5	160.2	53.6
GFXBench: T-Rex	53fps	53fps	53fps	60fps	60fps
GFXBench: Manhattan	27fps	27fps	29fps	60fps	47fps
Battery	3600mAh, non-removable	3000mAh, non-removable	2800mAh, removable	Lithium-ion	3400mAh, non-removable
Dimensions	151x73x7.8mm	142x70x7.9mm	149x74x7.7mm	138.3x67.1x7.1mm	152.7x74.7x7.4mm
Weight	157g	152g	159g	138g	158g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZDKDRE4	TINYURL.COM/J5CQ9OU	TINYURL.COM/JES3ZUD	TINYURL.COM/JKDLR6H	TINYURL.COM/GM92C55

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Best smartphones	**6** Xiaomi Mi 5s	**7** Google Pixel	**8** Apple iPhone 7 Plus	**9** Huawei Mate 9	**10** Google Nexus 6P
Price	£282 inc VAT	£599 inc VAT	£719 inc VAT	£599 inc VAT	£449 inc VAT
Website	Xiaomi-mi.co.uk	Google.co.uk	Apple.com/uk	Consumer.huawei.com/uk	Google.co.uk
Build rating	★★★★½	★★★★½	★★★★½	★★★★★	★★★★½
Features rating	★★★★½	★★★★☆	★★★★½	★★★★½	★★★★½
Value rating	★★★★★	★★★½☆	★★★½☆	★★★★☆	★★★★½
Performance rating	★★★★½	★★★★½	★★★★½	★★★★★	★★★★☆
Overall rating	★★★★½	★★★★☆	★★★★☆	★★★★½	★★★★½
OS (out of box)	Android 6.0 Marshmallow	Android 7.1 Nougat	iOS 10	Android 7.0 Nougat	Android 6.0 Marshmallow
Processor	Qualcomm Snapdragon 821	Qualcomm Snapdragon 821	Apple A10 Fusion	Kirin 960	Qualcomm Snapdragon 810
RAM	3/4GB	4GB	3GB	4GB	3GB
Storage	64/128GB	32/128GB	32/128/256GB	64GB	32/64/128GB
MicroSD support	✗	✗	✗	✓	✗
Graphics	Adreno 530	Adreno 530	PowerVR Series7XT Plus	Mali G71	Adreno 430
Screen size	5.15in	5in	5.5in	5.9in	5.7in
Screen resolution	1920x1080	1920x1080	1920x1080	1920x1080	2560x1440
Pixel density	428ppi	441ppi	401ppi	373ppi	518ppi
Screen technology	IPS	AMOLED	IPS	IPS	AMOLED
Front camera	4Mp	8Mp	7Mp	8Mp	8Mp
Rear camera	12Mp, LED flash	12.3Mp, LED flash	12Mp, LED flash	20Mp, LED flash	12.3Mp, LED flash
Video recording	4K	4K	4K	4K	4K
Cellular connectivity	4G	4G	4G	4G	4G
SIM type	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✗
Wi-Fi	802.11a/b/g/n/ac	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2
GPS	A-GPS, Glonass	A-GPS, Glonass	A-GPS	A-GPS	A-GPS, Glonass
NFC	✓	✓	✓	✓	✓
USB OTG	✓	✓	✓	✓	✓
Extra features	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner
Geekbench 4.0 (multi)	4157	4116	6106	5986	3939 (Geekbench 3.0)
JetStream	57.4	54.9	168.7	68.5	Not tested
GFXBench: T-Rex	59fps	58fps	58fps	60fps	34fps
GFXBench: Manhattan	43fps	47fps	44fps	34fps	14fps
Battery	3200mAh, non-removable	2770mAh, non-removable	2900mAh, non-removable	4000mAh, non-removable	3450mAh, non-removable
Dimensions	145.6x70.3x8.3mm	143.8x69.5x8.5mm	158.2x77.9x7.3mm	156.9x78.9x7.9mm	159.3x77.8x7.3mm
Weight	145g	143g	188g	190g	178g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/H6X5M3Z	TINYURL.COM/J4V6WVC	TINYURL.COM/ZSKOF5P	TINYURL.COM/J6N8TW2	TINYURL.COM/NABSV4E

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Best budget smartphones

	1 Motorola Moto G (3rd gen)	2 Vodafone Smart Ultra 6*	3 Vodafone Smart Prime 7*	4 Vodafone Smart Prime 6*	5 Xiaomi Redmi 3S
Price	£149 inc VAT	£125 inc VAT	£75 inc VAT	£79 inc VAT	£121 inc VAT
Website	Motorola.co.uk	Vodafone.co.uk	Vodafone.co.uk	Vodafone.co.uk	Xiaomi-mi.co.uk
Build rating	★★★★☆	★★★★½	★★★★½	★★★★½	★★★★☆
Features rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★★☆
Value rating	★★★★☆	★★★★★	★★★★½	★★★★☆	★★★★☆
Performance rating	★★★★½	★★★★½	★★★½☆	★★★★★	★★★★☆
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★½	★★★★☆
OS (out of box)	Android 5.1.1 Lollipop	Android 5.0.2 Lollipop	Android 6.0 Marshmallow	Android 5.0.2 Lollipop	MIUI 7.5
Processor	1.4GHz Snapdragon 410	2.5GHz Snapdragon 615	1.2GHz Snapdragon 210	1.2GHz Snapdragon 410	1.4GHz Snapdragon 4130
RAM	2GB	2GB	1GB	1GB	2GB
Storage	16GB	16GB	8GB	8GB	16GB
MicroSD support	Up to 32GB	Up to 128GB	Up to 128GB	Up to 64GB	Up to 128GB
Graphics	Adreno 406	Adreno 405	Adreno 304	Adreno 306	Adreno 505
Screen size	5in	5.5in	5in	5in	5in
Screen resolution	1280x720	1920x1080	1280x720	1280x720	1280x720
Pixel density	294ppi	401ppi	294ppi	294ppi	294ppi
Screen technology	IPS	IPS	IPS	IPS	IPS
Front camera	5Mp	5Mp	5Mp	2Mp	5Mp
Rear camera	13Mp	13Mp	8Mp	8Mp	13Mp
Video recording	720p	1080p	720p	1080p	1080p
Cellular connectivity	4G	4G*	4G*	4G*	4G
SIM type	Micro-SIM	Nano-SIM	Micro-SIM	Micro-SIM	1x Micro-SIM, 1x Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✓
Wi-Fi	802.11b/g/n	802.11b/g/n	802.11b/g/n	802.11b/g/n	802.11b/g/n
Bluetooth	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.1	Bluetooth 4.0	Bluetooth 4.1
GPS	GPS, A-GPS, GLONASS	GPS, A-GPS	A-GPS	A-GPS	GPS, A-GPS
NFC	✗	✓	✓	✗	✗
USB OTG	✗	✗	✗	✓	✗
Extra features	FM radio, accelerometer	FM radio	FM radio	FM radio	Rear-mounted fingerprint scanner
Geekbench 3.0 (single)	Not tested	649	Not tested	464	Not tested
Geekbench 3.0 (multi)	1628	2469	1098	1401	2848
SunSpider	1344ms	1545ms	Not tested	1301ms	Not tested
GFXBench: T-Rex	10fps	14fps	10fps	9.4fps	24fps
GFXBench: Manhattan	4fps	5.7fps	4fps	3.8fps	13fps
Battery	2470mAh, non-removable	3000mAh, non-removable	2540mAh, non-removable	Not specified	4100mAh, non-removable
Dimensions	142.1x72.4x11.6mm	154x77x9mm	144x72x8mm	141.65x71.89x9mm	139.3x69.6x8.5mm
Weight	155g	159g	128g	155g	144g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/HTEFW7H	TINYURL.COM/Q7Q9NXR	TINYURL.COM/ZTLQLUZ	TINYURL.COM/Q5DSNHE	TINYURL.COM/J8HXZ49

* Locked to Vodafone. All other models here are unlocked

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PC ADVISOR TEST CENTRE

Best budget smartphones

	6 Vodafone Smart Ultra 7*	7 Motorola Moto E 4G 2015	8 Cubot P12	9 Wileyfox Swift	10 Xiaomi Redmi Note 3
Price	£135 inc VAT	£109 inc VAT	£74 inc VAT	£129 inc VAT	£118 inc VAT
Website	Vodafone.co.uk	Motorola.co.uk	Cubot.net	Wileyfox.com	Xiaomi-mi.com
Build rating	★★★☆☆	★★★★☆	★★★★½	★★★★☆	★★★★½
Features rating	★★★☆☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Value rating	★★★☆☆	★★★★☆	★★★★★	★★★★½	★★★★½
Performance rating	★★★½☆	★★★★★	★★★½☆	★★★½☆	★★★★★
Overall rating	★★★☆☆	★★★★☆	★★★★☆	★★★★☆	★★★★½
OS (out of box)	Android 6.0.1 Marshmallow	Android 5.0 Lollipop	Android 5.1 Lollipop	Cyanogen OS	Android 5.0 Lollipop
Processor	1.8GHz Mediatek MT6755M	1.2GHz Snapdragon 410	1.3GHz MediaTek MT6580	1.2GHz Snapdragon 410	2GHz MediaTek MT6795
RAM	2GB	1GB	1GB	2GB	2GB
Storage	16GB	8GB	16GB	16GB	16GB
MicroSD support	Up to 256GB	Up to 32GB	Up to 32GB	Up to 32GB	No
Graphics	Mali-T860MP2	Adreno 306	Mali 400mp	Adreno 306	Not specified
Screen size	5.5in	4.5in	5in	5in	5.5in
Screen resolution	1920x1080	960x540	1280x720	1280x720	1920x1080
Pixel density	401ppi	245ppi	294ppi	294ppi	403ppi
Screen technology	IPS	IPS	IPS	IPS	Full HD
Front camera	5Mp	0.3Mp	5Mp	5Mp	5Mp
Rear camera	13Mp	5Mp	8Mp, LED flash	13Mp, LED flash	13Mp, LED flash
Video recording	1080p	720p	1080p	1080p	Not specified
Cellular connectivity	4G*	4G	3G	4G	4G
SIM type	Micro-SIM	Micro-SIM	Micro-SIM	Micro-SIM	Micro-SIM
Dual-SIM as standard	✗	✗	✓	✗	✓
Wi-Fi	802.11b/g/n	802.11b/g/n	802.11b/g/n	802.11b/g/n	802.11ac
Bluetooth	Bluetooth 4.1	Bluetooth 4.0	✗	Bluetooth 4.0	Bluetooth 4.0
GPS	GPS, A-GPS	GPS, A-GPS, Glonass	GPS, A-GPS	A-GPS	GPS, A-GPS, Glonass
NFC	✗	✗	✗	✗	✓
USB OTG	✗	✗	✓	✓	✗
Extra features	FM radio, accelerometer	Double-twist launches camera, lockscreen alerts	Gesture controls	3D G-Sensor	Fingerprint scanner
Geekbench 3.0 (single)	Not tested	464	Not tested	Not tested	Not tested
Geekbench 3.0 (multi)	3002	1463	1401	1456	4597
SunSpider	Not tested	1301ms	1726ms	1760ms	907ms
GFXBench: T-Rex	13fps	13fps	13fps	10fps	122fps
GFXBench: Manhattan	5.3fps	6fps	6fps	4fps	8fps
Battery	2960mAh, non-removable	2390mAh, non-removable	2200mmAh, removable	2500mAh, removable	4000mAh, non-removable
Dimensions	152.2x78.1x8.7mm	66.8x5.2-12.3x129.9mm	141x71x9.4mm	141x71x9.4mm	150x76x8.65mm
Weight	150g	145g	71.5x8.1x143.9mm	135g	164g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZL3X7QG	TINYURL.COM/Q7Q9NXR	TINYURL.COM/JVEOZSF	TINYURL.COM/PO9KG38	TINYURL.COM/JQNP2RB

* Locked to Vodafone. All other models here are unlocked

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Best phablets

	1 Xiaomi Mi Mix	2 Samsung Galaxy S7 edge	3 OnePlus 3T	4 Huawei Mate 9	5 Google Nexus 6P
Price	£639 inc VAT	£639 inc VAT	£399 inc VAT	£599 inc VAT	£449 inc VAT
Website	Xiaomi-mi.co.uk	Samsung.com/uk	Oneplus.net	Consumer.huawei.com/uk	Google.co.uk
Build rating	★★★★½	★★★★½	★★★★½	★★★★★	★★★★½
Features rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
Value rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★½
Performance rating	★★★★½	★★★★★	★★★★½	★★★★★	★★★★☆
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
OS (out of box)	Android 6.0 Marshmallow	Android 6.0 Marshmallow	Android 6.0.1 Marshmallow	Android 7.0 Nougat	Android 6.0 Marshmallow
Processor	Qualcomm Snapdragon 821	Qualcomm Snapdragon 820	Qualcomm Snapdragon 821	Kirin 960	Qualcomm Snapdragon 810
RAM	4/6GB	4GB	6GB	4GB	3GB
Storage	128/256GB	32GB	64/128GB	64GB	32/64/128GB
MicroSD support	✗	✓	✗	✓	✗
Graphics	Adreno 530	Adreno 530	Adreno 530	Mali G71	Adreno 430
Screen size	6.4in	5.5in	5.5in	5.9in	5.7in
Screen resolution	2040x1080	2560x1440	1920x1080	1920x1080	2560x1440
Pixel density	326ppi	534ppi	401ppi	373ppi	518ppi
Screen technology	IPS	IPS	AMOLED	IPS	Quad HD capacitive
Front camera	5Mp	5Mp	16Mp	8Mp	8Mp
Rear camera	16Mp, LED flash	16Mp, LED flash	16Mp, LED flash	20Mp, LED flash	12.3Mp, LED flash
Video recording	2160p	4K	4K	4K	4K
Cellular connectivity	4G	4G	4G	4G	4G
SIM type	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✗
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2
GPS	GPS, Glonass	GPS, Glonass	A-GPS, Glonass	A-GPS	A-GPS, Glonass
NFC	✓	✓	✓	✓	✓
USB OTG	✓	✓	✓	✓	✓
Extra features	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner
Geekbench 4.0 (single)	Not tested	Not tested	Not tested	Not tested	Not tested
Geekbench 4.0 (multi)	4301	6469 (Geekbench 3.0)	4257	5986	3939 (Geekbench 3.0)
SunSpider	Note tested	53fps	Not tested	Not tested	636ms
GFXBench: T-Rex	60fps	27fps	60fps	60fps	34fps
GFXBench: Manhattan	46fps	27fps	47fps	34fps	14fps
Battery	4400mAh, non-removable	3600mAh, non-removable	3400mAh, non-removable	4000mAh, non-removable	3450mAh, non-removable
Dimensions	158.8x81.9x7.9mm	151x73x7.8mm	152.7x74.7x7.4mm	156.9x78.9x7.9mm	159.3x77.8x7.3mm
Weight	209g	157g	158g	190g	178g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZC5LMDC	TINYURL.COM/ZDKDRE4	TINYURL.COM/GM92C55	TINYURL.COM/J6N8TW2	TINYURL.COM/NABSV4E

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Best phablets	6 Apple iPhone 7 Plus	7 Xiaomi Mi Note 2	8 Samsung Galaxy Note5	9 Apple iPhone 6s Plus	10 Google Pixel XL
Price	£719 inc VAT	£472 inc VAT	£499 inc VAT	£619 inc VAT	£719 inc VAT
Website	Apple.com/uk	Xiaomi-mi.co.uk	Samsung.com/uk	Apple.com/uk	Google.co.uk
Build rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
Features rating	★★★★½	★★★★☆	★★★★☆	★★★★½	★★★★☆
Value rating	★★★½☆	★★★★½	★★★★☆	★★★★☆	★★★★☆
Performance rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★☆
Overall rating	★★★★☆	★★★★½	★★★★½	★★★★½	★★★★☆
OS (out of box)	iOS 10	Android 7.1 Nougat	Android 5.1.1 Lollipop	iOS 9	Android 7.1 Nougat
Processor	Apple A10 Fusion	Qualcomm Snapdragon 821	2.1GHz Exynos 7420	A9	Qualcomm Snapdragon 821
RAM	3GB	4/6GB	4GB	2GB	4GB
Storage	32/128/256GB	64/128GB	32/64GB	16/64/128GB	32/128GB
MicroSD support	✗	✗	✗	✗	✗
Graphics	PowerVR Series7XT Plus	Adreno 530	Mali-T760MP8	M9	Adreno 530
Screen size	5.5in	5.7in	5.7in	5.5in	5.5in
Screen resolution	1920x1080	1920x1080	1280x720	1920x1080	2560x1440
Pixel density	401ppi	386ppi	518ppi	401ppi	534ppi
Screen technology	IPS	AMOLED	Super AMOLED	IPS	IPS
Front camera	7Mp	8Mp	5Mp	5Mp	8Mp
Rear camera	12Mp, LED flash	22.5Mp, LED flash	16Mp, LED flash	12Mp, LED flash	12.3Mp, LED flash
Video recording	4K	2160p	4K	4K	2160p
Cellular connectivity	4G	4G	4G	4G	4G
SIM type	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✗
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2
GPS	A-GPS	GPS, Glonass	A-GPS, Glonass	A-GPS, Glonass	GPS, Glonass
NFC	✓	✓	✓	✓	✓
USB OTG	✓	✓	✓	✓	✓
Extra features	Fingerprint scanner	Fingerprint scanner	Heart-rate sensor, fingerprint scanner	Fingerprint scanner	Fingerprint scanner
Geekbench 4.0 (single)	Not tested	1663	1497 (Geekbench 3.0)	2527 (Geekbench 3.0)	1581
Geekbench 4.0 (multi)	6106	4137	Not tested	4407 (Geekbench 3.0)	4067
SunSpider	Not tested	Not tested	718ms	210ms	Not tested
GFXBench: T-Rex	58fps	Not tested	37fps	59fps	55fps
GFXBench: Manhattan	44fps	31fps	15fps	38fps	30fps
Battery	2900mAh, non-removable	4070mAh, non-removable	2300mAh, non-removable	Lithium-ion	3450mAh, non-removable
Dimensions	158.2x77.9x7.3mm	156.2x77.3x7.6mm	153.2x76.1x7.6mm	158.2x77.9x7.3mm	154.7x75.7x8.5mm
Weight	188g	166g	171g	192g	168g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZSKOF5P	TINYURL.COM/GSOBSEE	TINYURL.COM/OCQAJPL	TINYURL.COM/OYRA5MX	TINYURL.COM/HBXFGXX

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Best tablets	**1** Apple iPad Air 2	**2** Samsung Galaxy Tab S2 8	**3** 9.7in Apple iPad Pro	**4** Apple iPad mini 4	**5** Sony Xperia Z3 Tablet Compact
Price	£399 inc VAT	£319 inc VAT	£499 inc VAT	£319 inc VAT	£299 inc VAT
Website	Apple.com/uk	Samsung.com/uk	Apple.com/uk	Apple.com/uk	Sony.co.uk
Build rating	★★★★★	★★★★½	★★★★½	★★★★½	★★★★☆
Features rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★½
Performance rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★½
Value rating	★★★★☆	★★★★☆	★★★½☆	★★★½☆	★★★★☆
Overall rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★½
OS (out of box)	iOS 10	Android 5.0 Lollipop	iOS 10	iOS 10	Android 4.4 KitKat
Processor	Apple A8X, Apple M8	1.9GHz Exynos 5433	Apple A9X, Apple M9	Apple A8, Apple M8	2.5GHz Snapdragon 801
RAM	2GB	3GB	3GB	2GB	3GB
Storage	16/64/128GB	32GB/64GB	32GB/128GB/256GB	16GB/64/128GB	16GB/32GB
MicroSD support	✗	Up to 128GB	✗	✗	Up to 128GB
Graphics	Apple A8X	Not specified	Apple A9X	Apple A8	Adreno 330
Screen size	9.7in	8in	9.7in	7.9in	8in
Screen resolution	2048x1536	2048x1536	2048x1536	2048x1536	1920x1200
Pixel density	264ppi	320ppi	264ppi	326ppi	283ppi
Screen technology	IPS	Super AMOLED	IPS	IPS	IPS
Front camera	1.2Mp	2.1Mp	8Mp	1.2Mp	2.2Mp
Rear camera	8Mp	8Mp	12Mp, LED flash	8Mp	8.1Mp
Video recording	1080p	QHD	1080p	1080p	1080p
Cellular connectivity	4G version available	4G version available	4G version available	4G version available	4G version available
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.0	Bluetooth 4.1	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.0
GPS	A-GPS, Glonass	A-GPS, Glonass	GPS in cellular model only	A-GPS, Glonass	A-GPS, Glonass
NFC	✗	✗	✗	✗	✓
USB OTG	✗	✓	✗	✗	✓
Fingerprint scanner	✓	✗	✓	✓	✗
Waterproof	✗	✗	✗	✗	✓
Extra features	None	None	Stereo speakers	None	PS4 Remote Play, stereo speakers
Geekbench 3.0 (single)	1816	Not tested	Not tested	1719	Not tested
Geekbench 3.0 (multi)	4523	4305	5257	3101	2708
JetStream	Not tested	Not tested	142	Not tested	1017ms
GFXBench: T-Rex	48fps	26fps	60fps	52fps	28fps
GFXBench: Manhattan	Not tested	11fps	34fps	25fps	11fps
Battery	7340mAh, non-removable	4000mAh, non-removable, Qi	7306mAh, non-removable	5124mAh, non-removable	4500mAh, non-removable
Dimensions	240x169.5x6.1mm	198.6x134.8x5.6mm	170x240x6.1mm	203.2x134.8x6.1mm	213x124x6.4mm
Weight	437g	265g	437g	304g	270g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/PLQXWSZ	TINYURL.COM/P37QFDW	TINYURL.COM/HFY7T4Z	TINYURL.COM/PBMONMA	TINYURL.COM/NJ6VHEO

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Best tablets	6 Google Pixel C	7 Huawei MediaPad M3	8 Amazon Fire	9 Sony Xperia Z4 Tablet	10 Xiaomi Mi Pad 2
Price	£399 inc VAT	£299 inc VAT	£49 inc VAT	£499 inc VAT	£144 inc VAT
Website	Google.co.uk	Consumer.huawei.com/uk	Amazon.co.uk	Sony.co.uk	Mi.com/en
Build rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
Features rating	★★★★½	★★★½☆	★★★★½	★★★★½	★★★★☆
Performance rating	★★★★½	★★★½☆	★★★★☆	★★★★½	★★★★½
Value rating	★★★★½	★★★★☆	★★★☆☆	★★★½☆	★★★★★
Overall rating	★★★★½	★★★★☆	★★★★☆	★★★★½	★★★★½
OS (out of box)	Android 6.0 Marshmallow	Android 6.0 Marshmallow	FireOS 5	Android 5.0 Lollipop	Android 5.1 Lollipop
Processor	Nvidia Tegra X1	Hisilicon Kirin 950	1.3GHz quad-core	Snapdragon 810	Intel Atom X5-Z8500
RAM	3GB	3GB	1GB	3GB	2GB
Storage	32GB/64GB	32GB/64GB	8GB	32GB	16GB/64GB
MicroSD support	✗	Up to 256GB	Up to 128GB	Up to 128GB	✗
Graphics	Nvidia Tegra X1	Mali-T880 MP4	Mali 450	Adreno 430	Intel HD Graphics
Screen size	10.2in	8.4in	7in	10.1in	7.9in
Screen resolution	2560x1800	2560x1600	1024x600	2560x1600	2048x1536
Pixel density	308ppi	359ppi	171ppi	299ppi	326ppi
Screen technology	IPS	IPS	IPS	IPS	IPS
Front camera	2Mp	8Mp	VGA	5.1Mp	5Mp
Rear camera	8Mp	8Mp	2Mp	8.1Mp	8Mp
Video recording	1080p	1080p	Not specified	1080p	Not specified
Cellular connectivity	✗	✗	✗	4G version available	✗
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac	802.11a/b/g/n	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.1	Bluetooth 4.1	Bluetooth 4.0	Bluetooth 4.1	Bluetooth 4.1
GPS	✗	✗	✗	A-GPS, Glonass	✗
NFC	✗	✗	✗	✓	✗
USB OTG	✗	✗	✗	✓	✗
Fingerprint scanner	✗	✓	✗	✗	✗
Waterproof	✗	✗	✗	✗	✗
Extra features	None	None	None	None	None
Geekbench 3.0 (single)	Not tested	Not tested	Not tested	Not tested	Not tested
Geekbench 3.0 (multi)	4048	5060 (Geekbench 4.0)	Not tested	4573	3280
JetStream	Not tested	Not tested	Not tested	580ms (SunSpider)	454
GFXBench: T-Rex	48fps	Not tested	Not tested	37fps	30fps
GFXBench: Manhattan	28fps	Not tested	Not tested	16fps	13fps
Battery	9000mAh, non-removable	5100mAh, non-removable	Not specified	6000mAh, non-removable	6190mAh, non-removable
Dimensions	242x179x7mm	215.5x124.2x7.3mm	191x115x10.6mm	254x167x6.1mm	200x133x7mm
Weight	517g	517g	313g	393g	322g
Warranty	1 year	1 year	1-year return-to-base	1 year	1 year
FULL REVIEW	TINYURL.COM/ZA79M7Z	TINYURL.COM/ZA79M7Z	TINYURL.COM/J3LJP7T	TINYURL.COM/JG34GZP	TINYURL.COM/H7DYTTL

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Best smartwatches	**1** Huawei Watch	**2** Apple Watch Series 2	**3** Motorola Moto 360 2	**4** Samsung Gear S2	**5** Fossil Q Founder
Price	£289 inc VAT	£369 inc VAT	£229 inc VAT	£199 inc VAT	£259 inc VAT
Website	Consumer.huawei.com/en	Apple.com/uk	Motorola.co.uk	Samsung.com/uk	Fossil.com/uk
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Operating system	Android Wear	iOS 10	Android Wear	Tizen-based OS	Android Wear
Compatibility	Android	iOS	Android, iOS	Android, iOS	Android, iOS
Display	1.4in 400x400 AMOLED	38mm, 340x272; 42mm, 390x312, AMOLED	1.37in 360x325 LCD	1.2in 360x360 AMOLED	1.5in, 360x326 LCD
Processor	Snapdragon 400	S2	Snapdragon 400	1GHz Exynos 3250	Intel Atom Z34XX
RAM	512MB	Not stated	512MB	512MB	1GB
Storage	4GB	4GB	4GB	4GB	4GB
Waterproof	✓	✓	✓	✓	✓
Battery	300mAh	273mAh	300mAh	250mAh	400mAh
Dimensions	42x11.3mm	38.6/42.5x33.3/36.4mm	42x11.4mm	42.3x49.8x11.4mm	47x13mm
Weight	40g	28.2g/34.2g	53.6g	47g	156g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/PXV9PVX	TINYURL.COM/HAT545L	TINYURL.COM/GUJR9XX	TINYURL.COM/P4UKB74	TINYURL.COM/Z3X6D6F

Best smartwatches	**6** Samsung Gear S3 Frontier	**7** LG G Watch R	**8** Asus ZenWatch 2	**9** Motorola Moto 360	**10** LG Watch Urbane
Price	£349 inc VAT	£195 inc VAT	£149 inc VAT	£199 inc VAT	£259 inc VAT
Website	Samsung.com/uk	Lg.com/uk	Uk.sasus.com	Motorola.co.uk	Lg.com/uk
Overall rating	★★★½☆	★★★★½	★★★★☆	★★★★½	★★★★☆
Operating system	Tizen-based OS	Android Wear	Android Wear	Android Wear	Android Wear
Compatibility	Android, iOS	Android	Android, iOS	Android	Android
Display	1.3in 360x360 Super AMOLED	1.3in 320x320 P-OLED	1.63in 320x320 LCD	1.56in 290x320 LCD	1.3in 320x320 P-OLED
Processor	1GHz Dual-core	1.2GHz Snapdragon 400	1.2GHz Snapdragon 400	TI OMAP 3	1.2GHz Snapdragon 400
RAM	768MB	512MB	512MB	512MB	512MB
Storage	4GB	4GB	4GB	4GB	4GB
Waterproof	✓	✓	✓	✓	✓
Battery	380mAh	410mAh	300mAh	320mAh	410mAh
Dimensions	46x49x12.97mm	46.4x53.6x9.7mm	40.7x49.6x10.9mm	46x11.5mm	46x52x10.9mm
Weight	62g (without strap)	62g	50g	49g (leather band model)	67g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/GSSNXZM	TINYURL.COM/QATY8FT	TINYURL.COM/ZVRZLNJ	TINYURL.COM/O9C69K6	TINYURL.COM/Q3VK7ES

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Best activity trackers

	1 Fitbit Charge 2	**2** Apple Watch Series 2	**3** Fitbit Charge HR	**4** Fitbit Alta	**5** Withings Steel HR
Price	£129 inc VAT	£369 inc VAT	£119 inc VAT	£99 inc VAT	£179 inc VAT
Website	Fitbit.com/uk	Apple.com/uk	Fitbit.com/uk	Fitbit.com/uk	Withings.com/uk
Overall rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★☆
Compatibility	iOS, Android, Windows	iOS	iOS, Android, Windows	iOS, Android, Windows	iOS, Android
Display	OLED	AMOLED	OLED	OLED	OLED
Pedometer	✓	✓	✓	✓	✓
Heart-rate monitor	✓	✓	✓	✗	✓
Sleep tracking	✓	✗	✓	✓	✓
Alarm	✓	✓	✓	✓	✓
Third-party app synching	✓	✓	✓	✓	✗
Call notifications	✓	✓	✓	✓	✓
Waterproof	✓	✓	✓	✓	✓
Battery life	5 days	18 hours	5+ days	5 days	25 days
Weight	35g	28.2g/34.2g	26g	32g	39/49g
FULL REVIEW	TINYURL.COM/Z3NN8RL	TINYURL.COM/HAT545L	TINYURL.COM/PCKV4SU	TINYURL.COM/ZO8TN2L	TINYURL.COM/HXHTT3O

Best activity trackers

	6 Xiaomi Mi Band 2	**7** Fitbit Surge	**8** Misfit Ray	**9** MyZone MZ-3	**10** Fitbit One
Price	£33 inc VAT	£199 inc VAT	£79 inc VAT	£129 inc VAT	£79 inc VAT
Website	Mi.com/en	Fitbit.com/uk	Misfit.com	Myzone.org	Fitbit.com/uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★½☆	★★★★½
Compatibility	iOS, Android	iOS, Android, Windows	iOS, Android	iOS, Android, Windows	iOS, Android
Display	OLED	Touchscreen	✗	✗	OLED
Pedometer	✓	✓	✓	✗	✓
Heart-rate monitor	✓	✓	✗	✓	✗
Sleep tracking	✓	✓	✓	✗	✓
Alarm	✓	✓	✓	✗	✓
Third-party app synching	✓	✓	✓	✗	✓
Call notifications	✓	✓	✓	✗	✗
Waterproof	✓	✓	✓	✓	✗
Battery life	20-day	5 days	6 months	7 months	10-14 days
Weight	7g (tracker only)	51g	8g	Not stated	8g
FULL REVIEW	TINYURL.COM/ZAF6OAW	TINYURL.COM/O83DR47	TINYURL.COM/JG3XVT9	TINYURL.COM/HK5JOXX	TINYURL.COM/PT2TC6F

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Best printers

	1 Canon Pixma MG7550	2 Samsung Xpress M2835DW	3 Brother HL-L9200CDWT	4 HP LaserJet Pro M277dw	5 HP OfficeJet 7510
Price	£130 inc VAT	£143 inc VAT	£548 inc VAT	£258 inc VAT	£129 inc VAT
Website	Canon.co.uk	Samsung.com/uk	Brother.co.uk	Hp.com/uk	Hp.com/uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Technology	Colour inkjet	Mono laser	Colour laser	Colour laser	Colour inkjet
Max print resolution	9600x2400dpi	4800x600dpi	2400x600dpi	300dpi	1200x600dpi
Actual print speed	B=14.3ppm	B=22.7ppm	B=30ppm C=30ppm	B=15ppm C=13ppm	B=12.5ppm C=7.5ppm
Scan/fax facilities	2400x4800dpi scanner	None	None	1200x1200dpi scanner, 300x300dpi fax	1200x1200dpi scanner, 300x300dpi fax
Supported interfaces	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, ethernet, 802.11b/g/n
Cost per page	B=2.4p C=8.1p	B=1.5p	B=1p C=5.9p	B=2.2p C=9p	B=1.7p C=3.3p
Media card/auto duplex	✗✓	✗✓	✗✓	✗✓	✗✓
Input capacity	125 sheets	250 sheets	750 sheets + 50 sheet	150 sheets + 50 sheet	250 sheets + 75 sheet
Dimensions	435x370x148mm	368x335x202mm	410x495x445mm	420x417x322mm	613x725x287mm
Weight	7.9kg	7.4kg	28.3kg	16.3kg	13kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/PZ3SVH7	TINYURL.COM/QECOF7V	TINYURL.COM/PT52MH6	TINYURL.COM/GPXACL7	TINYURL.COM/HDXF85Y

Best printers

	6 Epson EcoTank ET-2500	7 Epson Expression XP-640	8 HP LaserJet Pro MFP M130nw	9 Ricoh SP 150SUw	10 Canon Pixma MG3650
Price	£229 inc VAT	£119 inc VAT	£150 inc VAT	£129 inc VAT	£61 inc VAT
Website	Epson.co.uk	Epson.co.uk	Hp.com/uk	Ricoh.co.uk	Canon.co.uk
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★½☆
Technology	Colour inkjet	Colour inkjet	Mono laser	Mono laser	Colour inkjet
Max print resolution	5760x1440dpi	5760x1440dpi	600x600dpi	1200x600dpi	4800x1200dpi
Actual print speed	B=7.5ppm C=4ppm	B=12ppm C=8ppm	B=22ppm	B=20ppm	B=9ppm C=5ppm
Scan/fax facilities	2400x4800dpi scanner	2400x1200dpi scanner	600dpi scanner	1200dpi scanner	2400x1200dpi scanner
Supported interfaces	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, 802.11b/g/n, AirPrint	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, 802.11b/g/n	USB 2.0, 802.11b/g/n, AirPrint
Cost per page	B=0.2p C=0.4p	B=3.4p C=9.7p	B=3.5p	B=6p	B=2.8p C=4.5p
Media card/auto duplex	✗✗	✗✓	✗✓	✗✗	✗✓
Input capacity	100 sheets	100 sheets + 20 sheets	150 sheets + 100 sheets	50 sheets	100 sheets
Dimensions	169x489x300mm	130x385x335mm	230x383x260mm	350x275x137mm	152x449x304mm
Weight	4.6kg	6.7kg	7.6kg	7.5kg	5.4kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZWCECPA	TINYURL.COM/GSOR6KU	TINYURL.COM/ZEMNEJ9	TINYURL.COM/GVQ5XCT	TINYURL.COM/J8CNOV2

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Best wireless routers

	1 Apple AirPort Extreme	**2** TP-Link Archer VR900	**3** BT Smart Hub*	**4** Netgear Nighthawk R7000	**5** TP-Link VR2600
Price	£169 inc VAT	£139 inc VAT	£129 inc VAT	£150 inc VAT	£174 inc VAT
Website	Apple.com/uk	Tp-link.com	Bt.com	Netgear.co.uk	Tp-link.com
Overall rating	★★★★☆	★★★★½	★★★★★	★★★★½	★★★★½
Standards supported	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac
Frequency modes	2.4GHz/5GHz (concurrent)	2.4GHz/5GHz (concurrent)	2.4GHz/5GHz (concurrent)	2.4GHz/5GHz (concurrent)	2.4GHz/5GHz (concurrent)
Antennas	6x internal	3x external	7x internal	3x external	4x external
Built-in modem	✗	✓	✓	✗	✓
Manufacturer's rating	1300/450Mb/s	1300/600Mb/s	Not specified	1300/600Mb/s	1733/800Mb/s
WPS	✗	✓	✓	✓	✓
Ports	Gigabit WAN, 3x gigabit LAN, USB	Gigabit WAN, 1x USB 3.0, 1x USB 2.0	Gigabit LAN, 1x USB 3.0	Gigabit WAN, 1x USB 3.0, 1x USB 2.0	2x USB 3.0, 4 x RJ11
Average power use	8W	N/S	N/S	9W	N/S
Max speed (11n/11ac)	171/572Mb/s	146/622Mb/s	85/239.5Mb/s	171/592Mb/s	Not tested
Dimensions, weight	98x168x98mm, 945g	245x181x90mm, 720g	240x155x65mm	285x186x45mm, 750g	263.8x197.8x37.3mm
Warranty	1 year	Not specified	Not specified	Not specified	Not specified
FULL REVIEW	TINYURL.COM/MFDLLSC	TINYURL.COM/OF8KYPC	TINYURL.COM/ZL9TV96	TINYURL.COM/Q2NRQ8Q	TINYURL.COM/Z6E2DMG

* For BT broadband only

Best powerline adaptors

	1 TP-Link AV2000	**2** TrendNet Powerline 500 AV2	**3** TP-Link AV1200	**4** Solwise SmartLink 1200AV2	**5** Devolo dLan 1200+
Price	£99 inc VAT	£41 inc VAT	£88 inc VAT	£43 inc VAT	£119 inc VAT
Website	Uk.tp-link.com	Trendnet.com	Uk.tp-link.com	Solwise.com	Devolo.com/uk
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★½	★★★★½
No of adaptors in kit	2	2	2	1 (2 required)	2
Max throughput	2000Mb/s	600Mb/s	1200Mb/s	1200Mb/s	1200Mb/s
Near test result	432Mb/s	146Mb/s	500Mb/s	410Mb/s	357Mb/s
Far test result	117Mb/s	71Mb/s	200Mb/s	107Mb/s	126Mb/s
Ethernet ports	2x gigabit	1x gigabit	1x gigabit	2x gigabit	1x gigabit
Passthrough socket	Yes	No	Yes	Yes	Yes
Wireless hotspot	No	No	No	No	No
Encryption	128-bit	128-bit	128-bit	128-bit	128-bit
Dimensions	131x72x42mm	55x87x58mm	230x190x100mm	62x122x41mm	130x66x42mm
Weight	Not specified	90g	898g	Not specified	Not specified
Warranty	1 year	3 years	1 year	2 years	3 years
FULL REVIEW	TINYURL.COM/H9W89QM	TINYURL.COM/QYEPJQ7	TINYURL.COM/NVONCWT	TINYURL.COM/NZ4EJW8	TINYURL.COM/Q4EOO4M

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Best NAS drives

	1	2	3	4	5
	Synology 216+II	**Asustor AS1004T**	**Qnap TS-251A**	**WD My Cloud Mirror 4TB**	**Synology DS115j**
Price	£239 inc VAT (diskless)	£239 inc VAT (diskless)	£249 inc VAT (diskless)	£239 inc VAT (diskless)	£83 inc VAT (diskless)
Website	Synology.com	Asustor.com	Qnap.com	Wdc.com	Synology.com
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Drive bays	2	4	2	2	1
Processor	1.6GHz Intel Celeron N3060	1GHz Marvell ARMADA-385	1.6GHz Intel Celeron N3060	1.3GHz Marvell ARMADA-385	800MHz Marvell Armada 370
Memory	1GB DDR3	512MB	2GB DDR3	512MB	256MB DDR3
Remote access	✓	✓	✓	✓	✓
eSATA	✓	✗	✗	✗	✗
USB port	2x USB 3.0, USB 2.0	2x USB 3.0	3x USB 3.0, HDMI, USB 3.0 micro B	1x USB 3.0	2x USB 2.0
Raid options	0/1/JBOD/Basic/Synology Hybrid	0/1/5/6/10/JBOD	0/1/JBOD	0/1/JBOD	None
Software	DSM 6.1	Control Center	QTS 4.2	My Cloud	DSM 5.1
Dimensions	108x165x233.2mm	218x2165x164mm	102x169x219mm	139.9x170.6x49mm	71x161x224mm
Weight	1.25kg	1.5kg	1.28kg	1.6kg	700g
Warranty	2 years	3 years	2 years	2 years	1 year
FULL REVIEW	TINYURL.COM/JRWSCE3	TINYURL.COM/GLCBLG6	TINYURL.COM/JK6KQLN	TINYURL.COM/J76VSHR	TINYURL.COM/MNEYVNK

Best portable hard drives

	1	2	3	4	5
	Adata SE730	**Samsung Portable SSD T3**	**Transcend ESD400**	**SanDisk Extreme 500 Portable SSD**	**Western Digital My Passport**
Price	£106 inc VAT	£606 inc VAT	£420 inc VAT	£70 inc VAT	£159 inc VAT
Website	Adata.com	Samsung.com/uk	Transcend-info.com	Sandisk.co.uk	Wdc.com
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★★☆
Price per GB (at capacity tested)	46p	32p	39p	31p	4p
Capacity tested	250GB	2TB	256GB	240GB	4TB
Capacity range	250GB	250GB, 500GB, 1TB, 2TB	128GB, 256GB, 512GB, 1TB	120GB, 240GB, 480GB	1TB, 2TB, 3TB, 4TB
Storage	MLC NAND Flash	NAND Flash	NAND Flash	NAND Flash SSD	HDD
Sequential performance	380.8/278.5MB/s	406.9/211.2MB/s	410.8/163.8MB/s	398.3/203.4MB/s	119.3/112.8/s
4K performance	19.8/38.9MB/s	21.9/2.3MB/s	16.1/2.7MB/s	19.8/3.7MB/s	0.5/1.6MB/s
Other interfaces	USB 3.1 Gen 2 Type-C	USB 3.1 Gen 2 Type-C	USB 3.0	USB 3.0	USB 3.0
Encryption	None	256-bit AES	None	128-bit AES	256-bit AES
Software	None	T3 Security Enabler	Transcend Elite Data Management	SanDisk SecureAccess	WD Backup, WD Utilities
Dimensions	44x73x12mm	58x74x10mm	92x62x10.5mm	75.7x75.7x10.7mm	81.5x110x16.3mm
Weight	33g	51g	56g	79g	245g
Warranty	3 years	3 years	3 years	3 years	2 years
FULL REVIEW	TINYURL.COM/OABWL4B	TINYURL.COM/M72D3EP	TINYURL.COM/J43SQM5	TINYURL.COM/HNKNV3M	TINYURL.COM/GP6JNCM

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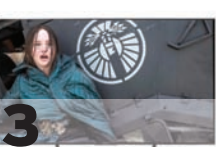| Best SSDs	Samsung 850 Evo (500GB)	Toshiba Q300 (480GB)	Samsung 960 Pro (512GB)	Samsung 960 Evo (1TB)	Samsung 850 Pro (1TB)
	1	**2**	**3**	**4**	**5**
Price	£109 inc VAT	£79 inc VAT	£311 inc VAT	£404 inc VAT	£365 inc VAT
Website	Samsung.com/uk	Toshiba.co.uk	Samsung.com/uk	Samsung.com/uk	Samsung.com/uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
Price per GB	23p	18p	65p	43p	36.5p
4K performance	36.3/106.2MB/s	29.8/65.1MB/s	41.5/165.9MB/s	32.8/50.2MB/s	36/89MB/s
Sequential performance	525.4/512.1MB/s	529.3/511.5MB/s	2048.8/1822.7MB/s	1717.8/1729.8MB/s	508/482MB/s
Memory cache	512MB DDR3 SDRAM	Unknown	512MB DDR3	1GB	1GB LPDDR2
Controller	Samsung MGX	Toshiba TC58NC1000	Samsung Polaris	Samsung Polaris	Samsung MCX
Encryption	AES 256-bit	None	AES 256-bit	AES 256-bit	AES 256-bit
Flash	Samsung 3D V-NAND	TLC NAND	Samsung V-NAND	Samsung V-NAND	Samsung 40nm V-NAND MLC
Connection	SATA III 6GB/s	SATA III 6GB/s	NVMe 1.2	NVMe 1.2	SATA III 6GB/s
Power consumption	4.7W active/0.5W idle	3.6W active/0.3W idle	5.1W active/0.4W idle	5.7W active/0.4W idle	5.8W active/0.6W idle
Warranty	5 years	3 years	5 years	3 years	10 years
Dimensions	69.85x100x6.8mm	69.85x100x7mm	22.15x80.15x2.38mm	22.15x80.15x2.38mm	69.85x100x6.8mm
FULL REVIEW	TINYURL.COM/JB2VWLF	TINYURL.COM/ZZBWFJZ	TINYURL.COM/JOQMWUE	TINYURL.COM/HBSLQJD	TINYURL.COM/OVHDALD

Smart thermostats	Heat Genius	Honeywell EvoHome	Nest Learning Thermostat	Hive Active Heating 2	Tado
	1	**2**	**3**	**4**	**5**
Price (from)	£249 inc VAT	£249 inc VAT	£199 inc VAT	£179 inc VAT	£199 inc VAT
Website	Heatgenius.co.uk	Honeywelluk.com	Nest.com	Hivehome.com	Tado.com/gb
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Zones controlled	6	12	1	1	1
Hot water control	✓	✓	✗	✓	✓
Underfloor heating	✗	✓	✗	✗	✗
Warranty	2 years	18 months	2 years	1 year	1 year
Verdict	Heat Genius is very good at a very useful thing. It is easy to use and efficient. How long it takes to pay for itself will depend on your circumstances, and it may be that a full system is too much of a long-term investment for you. If you are looking to install in your a zoned smart heating system, we are happy to recommend Heat Genius.	EvoHome is the best smart heating system we've tested. It isn't perfect though, and it's also very expensive, or can be. But if you value convenience and comfort above saving money, it's the one to buy.	If you need only a single thermostat and don't need control over hot water, the Nest is a good choice. The Nest Protect smoke and carbon monoxide alarm also works with the thermostat, but it's not cheap. There's also the Nest Cam, but the tie-in with the thermostat is minimal.	The Hive Active Heating system is a great upgrade for anyone that wants or needs the ability to be able to control their heating remotely. It's by no means the most advanced smart thermostat, but it will do the job at a good price for a lot of people.	Tado is the best smart thermostat if you like the idea of presence detection as it simply follows you and your smartphone via GPS, and turns the heating up or down as you get further away or nearer home. There's also hot water control, but the thermostat itself isn't the best looking.
FULL REVIEW	TINYURL.COM/Q2TUKL9	TINYURL.COM/Q3CXA4Z	TINYURL.COM/N9MWV4G	TINYURL.COM/PDLCSAS	TINYURL.COM/O4K3A2A

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Best graphics cards	**1**	**2**	**3**	**4**	**5**
	Asus ROG Strix GTX 1080	MSI GTX 1070 Gaming X 8G	Zotac GeForce GTX 1050 Ti	Nvidia GTX 1080 Founders Ed	Nvidia GTX 1060 Founders Ed
Price	£659 inc VAT	£419 inc VAT	£149 inc VAT	£619 inc VAT	£275 inc VAT
Website	Asus.com/uk	Uk.msi.com	Zotac.com	Nvidia.co.uk	Nvidia.co.uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Graphics processor	Nvidia GeForce GTX 1080	Nvidia GeForce GTX 1070	Nvidia GeForce GTX 1050 Ti	Nvidia GeForce GTX 1080	Nvidia GeForce GTX 1060
Installed RAM	8GB	8GB	4GB DDR5	8GB	6GB
Memory interface	256-bit	256-bit	128-bit	256-bit	192-bit
Core clock/boost	1759/1898MHz	1607/1797MHz	1392/506MHz	1607/1733MHz	1506/1708MHz
Memory clock	10,010MHz	4006MHz	7GHz	10,000MHz	4006MHz
Stream processors	2560	1920	768	2560	1280
Texture units	160	120	48	160	80
Power connectors	1x 8-pin, 1x 6-pin	1x 8-pin, 1x 6-pin		1x 8-pin	2x 6-pin
DirectX	12	12	12	12	12
Digital interface	DVI, 2x HDMI, 2x DisplayPort	DVI, HDMI, 3x DisplayPort	DVI-D, HDMI, DisplayPort	DVI, HDMI, 3x DisplayPort	DVI, HDMI 2.0, 3x DisplayPort 1.4
Warranty	3 years	3 years	3 years	3 years	3 years
FULL REVIEW	TINYURL.COM/HL4SOJ2	TINYURL.COM/J6HWN55	TINYURL.COM/J6HWN55	TINYURL.COM/ZEQXYQU	TINYURL.COM/HH6TYT8

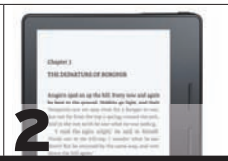| **Best graphics cards**	**6**	**7**	**8**	**9**	**10**
	XFX Radeon RX 480	Palit GeForce GTX 1050	XFX AMD Radeon RX460	Sapphire Radeon R7 250X	Asus GeForce GTX 980 Ti
Price	£249 inc VAT	£107 inc VAT	£129 inc VAT	£65 inc VAT	£639 inc VAT
Website	Novatech.co.uk	Palit.com	Xfxforce.com	Sapphiretech.com	Asus.com/uk
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★½	★★★★★
Graphics processor	AMD Radeon RX480	Nvidia GeForce GTX 1050	AMD Radeon RX 460	AMD Radeon R7 250X	nVidia GeForce GTX 980 Ti
Installed RAM	8GB	2GB GDDR5	4GB GDDR5	1GB GDDR5	12GB
Memory interface	256-bit	128-bit	128-bit	128-bit	384-bit
Core clock/boost	1120/1288MHz	1345/1455MHz	1220MHz	950MHz	1216/1317MHz
Memory clock	7000MHz	7GHz	7GHz	1125/4500MHz	7200MHz
Stream processors	2304	640	896	640	2816
Texture units	144	40	56	40	172
Power connectors	1x 6-pin	None	1x 6-pin	1x 6-pin	2x 8-pin
DirectX	12	12	12	12	12
Digital interface	3x DP 1.4, HDMI	DVI-D, HDMI, DisplayPort	DVI-D, HDMI, DisplayPort	1x DVI, HDMI, DisplayPort	DVI, HDMI 2.0, 3x DisplayPort 1.2
Warranty	2 years	2 years	3 years	2 years	3 years
FULL REVIEW	TINYURL.COM/HSVQWBQ	TINYURL.COM/JSJK88H	TINYURL.COM/JKSP5OE	TINYURL.COM/OLJ83SQ	TINYURL.COM/NDZZQKJ

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Best 4K TVs

	1 Panasonic TX-50CX802B	2 Samsung UE48JU7000	3 Sony KD-55X8505C	4 Philips 40PUT6400	5 Finlux 55UX3EC320S
Price	£1,299 inc VAT	£1,200 inc VAT	£1,200 inc VAT	£449 inc VAT	£799 inc VAT
Website	Panasonic.co.uk	Samsung.com/uk	Sony.co.uk	Philips.co.uk	Finlux.co.uk
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★½☆
Screen size	50in	48in	55in	40in	55in
Panel type	LCD (LED)	LCD (LED)	LCD (LED)	LCD (LED)	LCD (LED)
Native resolution	3840x2160	3840x2160	3840x2160	3840x2160	3840x2160
3D enabled	✓	✓	✓	✗	✗
Apps	BBC iPlayer, ITV Player, All 4, Demand 5, Netflix, YouTube, Amazon	BBC iPlayer, ITV Player, All 4, Netflix, Amazon, YouTube and apps store	YouView with BBC iPlayer, ITV Player, All 4 and Demand 5; Netflix, YouTube, Amazon	BBC iPlayer, Netflix, YouTube, Spotify Connect, Daily Motion, Philips App Store, Google Play	BBC iPlayer, Netflix, YouTube, Twitter, Facebook, Viewster, Flickr
Networking	Ethernet, Wi-Fi, Wi-Fi Direct	Ethernet, Wi-Fi, Wi-Fi Direct	Ethernet, Wi-Fi, Wi-Fi Direct	Ethernet, Wi-Fi, Wi-Fi Direct	Ethernet, Wi-Fi
Inputs	3x HDMI, 3x USB	4x HDMI, 3x USB	4x HDMI, 3x USB	4x HDMI, 3x USB	4x HDMI, 3x USB
Dimensions	112.1x4.6x65.2cm	108.7x6.7x63cm	123.6x6x72.2cm	90.4x8.3x52.6m	123.3x10.6x71.3cm
Weight	18kg	11.1kg	19.9kg	7.8kg	17.2kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZLFQ3JV	TINYURL.COM/Q2W3VZY	TINYURL.COM/ZGSP9FM	TINYURL.COM/JQVWCFU	TINYURL.COM/P934VXT

Best 4K flat-panel displays

	1 BenQ BL3201PT	2 Philips BDM4065UC	3 BenQ RL2460HT	4 AOC G2460VQ6	5 ViewSonic VX2457-mhd
Price	£699 inc VAT	£600 inc VAT	£168 inc VAT	£122 inc VAT	£139 inc VAT
Website	Benq.co.uk	Philips.co.uk	Benq.co.uk	Aoc-europe.coom	Viewsoniceurope.com/uk
Overall rating	★★★★☆	★★★★☆	★★★★½	★★★★☆	★★★★☆
Screen size	32in	40in	24in	24in	23.6in
Panel type	IPS	VA	TN matt	TN matt	TN matt
Native resolution	3840x2160	3840x2160	1920x1080	1920x1080	1920x1080
Pixel density	157ppi	110ppi	92ppi	92ppi	93ppi
Brightness	350cd/m²	120cd/m²	250cd/m²	250cd/m²	300cd/m²
Static contrast ratio	1000:1	5000:1	1000:1	1000:1	1000:1
Response time	4ms	8.5ms	1ms	1ms	2ms
Ports	DVI-DL, HDMI, DP, mDP	HDMI, DP, mDP, VGA	2x HDMI, DVI, VGA, Aux in/out, HDMI out	DP, HDMI, VGA, Aux in/out	DP, HDMI, VGA, Aux in/out
Dimensions	490.2x740.3x213.4mm	904x512x88mm	579x213x502mm	565.4x219.3x411.6mm	558.7x229.6x422.4mm
Weight	12.5kg	8.5kg	5.2kg	4.27kg	4.08kg
Warranty	3 years	2 years	3 years	3 years	2 years
FULL REVIEW	TINYURL.COM/NPA62QL	TINYURL.COM/Q2W3VZY	TINYURL.COM/ZA48HDY	TINYURL.COM/HOGLYL3	TINYURL.COM/HBVD2GD

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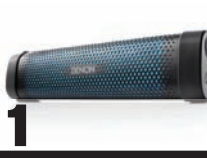
	1 Amazon Kindle Voyage	2 Amazon Kindle Oasis	3 Amazon Kindle (8th gen)	4 Amazon Kindle Paperwhite	5 Amazon Kindle (7th gen)
Price	£169 inc VAT	£269 inc VAT	£59 inc VAT	£109 inc VAT	£59 inc VAT
Website	Amazon.co.uk	Amazon.co.uk	Amazon.co.uk	Amazon.co.uk	Amazon.co.uk
Overall rating	★★★★☆	★★★★☆	★★★½☆	★★★★☆	★★★½☆
Screen size	6in touchscreen	6in touchscreen	6in touchscreen	6in touchscreen	6in touchscreen
Screen technology	E Ink	E Ink	E Ink	E Ink	E Ink
Screen resolution	1440x1080	1440x1080	600x800	768x1024	600x800
Built-in light	✓	✓	✗	✓	✗
Storage	4GB	4GB	4GB	2GB	4GB
Book store	Amazon Kindle	Amazon Kindle	Amazon Kindle	Amazon Kindle	Amazon Kindle
Cellular connectivity	Optional extra	Optional extra	✗	Optional extra	✗
Battery life	Six weeks	Eight weeks	Four weeks	Eight weeks	Four weeks
Dimensions	162x115x7.6mm	143x122x8.5mm	160x115x9.1mm	117x169x9.1mm	169x119x10.2mm
Weight	180g	131g	161g	206g	191g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/NXAAU3Q	TINYURL.COM/Z924POY	TINYURL.COM/HJONZA4	TINYURL.COM/PREZPRK	TINYURL.COM/NSFORJE

Best media streamers

	1 Roku Streaming Stick	2 Roku 3	3 Google Chromecast 2	4 Amazon Fire TV Stick	5 Google Chromecast Ultra
Price	£49 inc VAT	£99 inc VAT	£30 inc VAT	£35 inc VAT	£69 inc VAT
Website	Roku.com	Roku.com	Play.google.com	Apple.com/uk	Play.google.com
Overall rating	★★★★½	★★★★☆	★★★★☆	★★★★☆	★★★★½
Type	Dongle	Set-top box	Dongle	Dongle	Dongle
Ports	HDMI, Micro-USB	HDMI, USB, ethernet	HDMI, Micro-USB	HDMI, Micro-USB	HDMI, Micro-USB
Processor	600MHz single-core	900MHz single-core	13.GHz dual-core	Dual-core	Not specified
RAM	512MB	512MB	512MB	1GB	Not specified
Graphics	Not specified	Not specified	Not specified	Not specified	Not specified
Storage	None	512MB, plus microSD slot	None	8GB (not user-accessible)	None
Voice search	✗	✓	✗	✗	No
Remote control	✓	✓	✗	✓	No
Dimensions	78.7x27.9x12.7mm	89x89x25mm	52x52x13.5mm	84.9x25x11.5mm	58.2x13.7x58.2mm
Weight	18g	170g	39g	25g	Device 47g; adaptor 101g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/OAP9QF9	TINYURL.COM/PT7MGUL	TINYURL.COM/Q4B6B29	TINYURL.COM/NAQRNOC	TINYURL.COM/ZZJD5KQ

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Best games consoles	1 Sony PlayStation 4 Pro	2 Microsoft Xbox One S	3 Sony PlayStation 4 Slim	4 Sony PlayStation 4	5 Microsoft Xbox One
Price	£349 inc VAT	£349 inc VAT	£259 inc VAT	£259 inc VAT	£349 inc VAT
Website	Playstation.com	Xbox.com	Playstation.com	Playstation.com	Xbox.com
Overall rating	★★★★½	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Processor	Octa-core AMD x86-64	1.75GHz octa-core AMD x86	Octa-core AMD x86	Octa-core AMD x86	1.75GHz octa-core AMD x86
Graphics	4.2TFlops AMD Radeon GPU	AMD Radeon GPU at 914MHz	1.84TFlops AMD Radeon GPU	1.84TFlops AMD Radeon GPU	1.31TFlops AMD Radeon GPU
RAM	8GB GDDR5	8GB DDR3	8GB GDDR5	8GB GDDR5	8GB DDR3
Storage	1TB	500GB, 1TB or 2TB	500GB	500GB	500GB
Optical drive	Blu-ray, DVD, game discs	4K Blu-ray, DVD, game discs	Blu-ray, DVD, game discs	Blu-ray, DVD, game discs	Blu-ray, DVD, game discs
Ports	3x USB 3.1, AUX, HDMI	3x USB 3.0, HDMI 2.0, Kinect port	2x USB 3.0, AUX, HDMI	2x USB 3.0, AUX, HDMI	USB 3.0, HDMI
Connectivity	Ethernet, 802.11b/g/n/ac, Bluetooth	Ethernet, 802.11b/g/n/ac	Ethernet, 802.11b/g/n, Bluetooth	Ethernet, 802.11b/g/n, Bluetooth	Ethernet, 802.11b/g/n
Other	1 controller	1 controller, 4K, Kinect option	1 controller	1 controller	1 controller, 4K, Kinect option
Dimensions	327x295x55mm	3294x226x64mm	275x53x305mm	275x53x305mm	333x274x79mm
Weight	3.3kg	2.9kg	2.8kg	2.8kg	3.2kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/HCNB3XP	TINYURL.COM/HWO8PJU	TINYURL.COM/HUL2J8Q	TINYURL.COM/NBFLQK2	TINYURL.COM/M6J4KHS

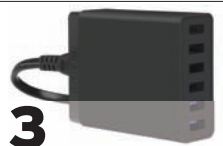| Best budget portable speakers	1 Denon Envaya Mini	2 Sumvision Psyc Monic	3 Lava BrightSounds 2	4 UE Roll	5 Marsboy 5W Orb
Price	£99 inc VAT	£37 inc VAT	£39 inc VAT	£99 inc VAT	£38 inc VAT
Website	Denon.com	Sumvision.com	Lavaaccessories.co.uk	Ultimateears.com	Amazon.co.uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★☆
Speaker(s)	Not specified	Not specified	Not specified	Not specified	Not specified
Bluetooth	Bluetooth 4.0	Bluetooth 4.0	Bluetooth	Bluetooth	Bluetooth 4.1 + EDR
Handsfree calls	✓	✗	✓	✗	✗
NFC	✓	✗	✗	✓	✗
Frequency response	Not specified	90Hz to 20KHz	Not specified	108Hz to 20kHz	80Hz to 18kHz
Impedence	Not specified	Not specified	Not specified	Not specified	4 ohms
Extra features	IPX4 splashproof	None	IPX4 water resistance	IPX7 splashproof	MicroSD slot
Claimed battery life	10 hours	7 hours	36 hours	9 hours	12 hours
Dimensions	209x54x51mm	200x60x60mm	190x95x103mm	134x39x40mm	150x148x138mm
Weight	558g	Not stated	624g	330g	454g
Warranty	1 year	1 year	1 year	2 years	1 year
FULL REVIEW	TINYURL.COM/QDRNP3P	TINYURL.COM/JC8CZM2	TINYURL.COM/ZZ7HUDG	TINYURL.COM/O7T7ZUU	TINYURL.COM/JJLOPCD

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Best headphones

	1	2	3	4	5
	B&W P9 Signature	**Bose QuietComfort 35**	**Denon AH-D600**	**Sharkk Bravo**	**Denon AH-MM400**
Price	£699 inc VAT	£289 inc VAT	£229 inc VAT	£249 inc VAT	£196 inc VAT
Website	Bowers-wilkins.co.uk	Bose.co.uk	Denon.co.uk	Sharkk.com	Denon.co.uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Type	Circumaural over-ear	Circumaural over-ear	Circumaural over-ear	Circumaural over-ear	Circumaural over-ear
Frequency response	Not stated	Not stated	5Hz to 45kHz	6Hz to 45kHz	10Hz to 40kHz
Nominal impedance	Not stated	Not stated	25 ohms	32 ohms	32 ohms
Sensitivity	Not stated	Not stated	108dB	118dB	96dB
In-line remote	✗	✗	✓	✗	✓
Mic	✓	✓	✓	✗	✓
Extra tips	N/A	N/A	N/A	N/A	N/A
Carry case	✓	✓	✓	✓	✓
Cable length	Not stated	1.2m	3m	1.35m	Not stated
Weight	413g	310g	250g	294g	310g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/HDR2UUG	TINYURL.COM/JZWSSSQ	TINYURL.COM/NBCFJW6	TINYURL.COM/Z5BGX9X	TINYURL.COM/J7G56N9

Best headphones

	6	7	8	9	10
	Bose QuietComfort 20	**Rock Jaw Resonate**	**Final Audio Design Sonorous III**	**Audio-Technica ATH-WS99**	**B&W P5**
Price	£259 inc VAT	£124 inc VAT	£299 inc VAT	£79 inc VAT	£249 inc VAT
Website	Bose.co.uk	Rockjawaudio.com	Final-audio-design.com	Eu.audio-technica.com/en	Bowers-wilkins.co.uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★½
Type	In-ear	In-ear	Circumaural over-ear	Over-ear	On-ear, foldable
Frequency response	20-21kHz	20-20kHz	Not stated	8Hz to 25kHz	10Hz to 20kHz
Nominal impedance	32 ohms	16 ohms	25 ohms	37 ohms	22 ohms
Sensitivity	105dB	103dB	105dB	120dB	108dB
In-line remote	✓	✓	✗	✓	✗
Mic	✓	✓	✗	✓	✓
Extra tips	✓	✓	N/A	N/A	N/A
Carry case	✓	✓	✗	✗	✗
Cable length	1.3m	1.25m	1.5m	0.8m	1.2m
Weight	44g	40g	410g	250g	195g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/OEAGFOF	TINYURL.COM/JSBC8FZ	TINYURL.COM/JQW529E	TINYURL.COM/QDRCCAT	TINYURL.COM/NNRV6UT

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Best power banks

	1 Zendure A2 (2nd gen)	2 Anker PowerCore 10000	3 Omnicharge	4 RavPower PowerStation	5 CHJDG UltraCompact
Price	£25 inc VAT	£20 inc VAT	£103 inc VAT	£99 inc VAT	£19 inc VAT
Website	Zendure.com	Anker.com	Omnicharge.co	Ravpower.com	Chargedpower.com
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★☆
Capacity	6700mAh	10,000mAh	13,600mAh	20,100mAh	10,000mAh
Input	1x 7.5W Micro-USB	1x 10W Micro-USB	DC 4.5-36V, 1W-34W	19V/1.6A DC	1x 5W Micro-USB
Outputs	1x 10.5W USB	1x QC 3.0 USB	2x 4.8A USB ports, plug socket	5V USB-C, 3A output	1x 10.5W USB
Auto-on/-off	✓	✓/✗	✗	✗/✗	✓/✗
Passthrough charging	✓	✗	✓	✗	✓
Status indicator	4 LEDs	4 LEDs	OLED display	5 LEDs	4 LEDs
LED flashlight	✗	✗	✗	✓	No
Carry case	✓	✗	✗	✓	No
Dimensions	93x48x23mm	92x60x22mm	135x85x23.5mm	69x69x146mm	93x19x63mm
Weight	137g	188g	365g	207g	181g
Warranty	1 year	1 year	1 year	18 months	1 year
FULL REVIEW	TINYURL.COM/NGCNO5F	TINYURL.COM/ZSREH65	TINYURL.COM/JL97MK5	TINYURL.COM/H48JZWL	TINYURL.COM/JMOUUUO

Best desktop chargers

		1 Tronsmart Titan	2 Tronsmart U5PTA	3 CHOEtech 6-port Charger	4 Aukey USB Charging Station	5 iClever USB Travel Charger
Price		£25 inc VAT	£22 inc VAT	£25 inc VAT	£17 inc VAT	£20 inc VAT
Website		Tronsmart.com	Tronsmart.com	Choetech.com	Hisgadget.com	Hisgadget.com
Overall rating		★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Max output		90W	54W	60W	54W	50W
Outputs:	USB 1	QC 2.0	QC 3.0	QC 2.0	QC 2.0	12W USB
	USB 2	QC 2.0	12W	QC 2.0	12W	12W USB
	USB 3	QC 2.0	12W	12W	12W	12W USB
	USB 4	QC 2.0	12W	12W	12W	12W USB
	USB 5	QC 2.0	12W	12W	12W	12W USB
	USB 6	N/A	N/A	12W	N/A	12W USB
Colours available		Black	Black	Black	Black	Black
Dimensions		160x81x28mm	165x156x56mm	71.5x29x88.4mm	94x60x25mm	100x69x27mm
Weight		292g	390g	158g	149g	180g
Warranty		1 year	18 months	1 year	1 year	1 year
FULL REVIEW		TINYURL.COM/GMVDCHM	TINYURL.COM/QG4X5D9	TINYURL.COM/QG4X5D9	TINYURL.COM/P2CZMCU	TINYURL.COM/MPA4DWC

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Ubuntu back as a desktop distribution

Ubuntu dumping Unity is a good thing, argues **Alex Campbell**

Hey, Ubuntu users: if you haven't heard yet, Canonical killed off any hopes of releasing Unity 8 with Ubuntu 18.04 LTS next year. Instead, Ubuntu will release 18.04 with the GNOME desktop. While some die-hard Ubuntu fans may have a case of inconsolable angst, this is not as bad of a thing as it may seem.

A brief history of Ubuntu desktops

A long time ago (in internet time anyway), the Ubuntu OS shipped with the GNOME 2 desktop environment, which was beloved at the time. During that era, only a handful desktop environments were widely used. GNOME and KDE took the lion's share of users, while the lighter-weight XFCE and LXDE desktops catered to users who wanted a speedier desktop and less pizzazz.

When Ubuntu first shipped the Unity desktop in 2010, it was meant to cater to netbooks. (I still have my Eee PC from back then.) As netbooks were supplanted by the rise of tablets, Chromebooks, and ultrabooks, Unity stayed with the OS. If you wanted the old GNOME desktop, there was a distro for you: Ubuntu GNOME. Like Kubuntu (Ubuntu with KDE), Ubuntu

GNOME was essentially the same OS, but with the GNOME desktop instead of Unity.

When the GNOME desktop hit version 3.0, the desktop experience was split yet again. The MATE project is basically a fork of the old GNOME 2 desktop, which resulted in the Ubuntu MATE desktop. Ubuntu GNOME, meanwhile, stuck with the GNOME project's trajectory and offered up the GNOME 3 desktop for Ubuntu users who wanted it.

Why the move is a good thing

Ubuntu has been a leading distribution in the desktop Linux scene. It's reasonably easy to install, you can find .deb software packages everywhere, and the user experience has one of the lower learning curves of any Linux distribution. Since it has such a large user base, what Ubuntu does on the desktop has a significant impact on the Linux desktop across distributions.

The abandonment of Unity signifies a reversal for Canonical, the company that produces Ubuntu. Canonical had drawn criticism for going its own way with Unity and reinventing the wheel instead of making existing projects better. By giving

up on Unity, Canonical frees up resources to work on other projects.

In a blog post announcing Unity's demise, the company's founder Mark Shuttleworth mentioned that Canonical would actively work on the future of the desktop. "We will continue to produce the most usable open-source desktop in the world, to maintain the existing LTS releases, to work with our commercial partners to distribute that desktop, to support our corporate customers who rely on it, and to delight the millions of IoT and cloud developers who innovate on top of it," he said.

Contributors who want to work on the Ubuntu desktop can now contribute to the GNOME project. It doesn't require the contributor to sign a contributor's license agreement, which has been a key issue for many of Canonical's critics. Additionally, the added attention the GNOME project will receive by virtue of an increased user base will ultimately make the GNOME desktop better. With more people using the desktop comes increased demand for features and bug fixes, as well as more people to submit bug reports.

If you're a desktop user, it means that the future versions of Ubuntu's desktop will be more consistent with other distributions of Linux, and that the Linux community at large will likely benefit.

What's not so great about all this

The first thing to die along with Unity is Canonical's goal of convergence between desktops and mobile devices. The death of Unity means that, like Firefox OS before it, Ubuntu-based tablets and phones ultimately get the axe. As someone who's wanted an alternative to iOS, Android, and Windows, this represents a reduction in choice for the consumer.

The big unknown in all of this is the development of Mir. Mir is pretty much Canonical's Wayland, which is a replacement for the aging X.org video server. In case I just lost you, X.org, Wayland or Mir would be the part of the OS that actually draws the pixels of the graphical environment on the screen. Without X.org, Wayland, or Mir, you only have a text console.

Since Mir was meant to be the underlying video server for Unity 8, it really has lost its raison d'être. Shuttleworth makes no mention of Mir in his blog post, but it may be safe to assume that Mir will also cease to be. Without Unity 8 and the convergence it promised, there's no reason to use Mir instead of Wayland.

What Ubuntu users can expect

In the next LTS release, Ubuntu GNOME will effectively be merged into the main desktop release of Ubuntu. If you're using Ubuntu now on Unity, there will be a few changes in the desktop itself, but the apps you use will largely be the same.

For all of its differences, Unity actually borrows a lot from the GNOME project. Applications are drawn using other GTK 3 framework, just like apps on the GNOME 3 desktop. In fact, most of the settings in Ubuntu are the exact same applications.

The GNOME desktop differs from the Unity desktop in a couple ways, however. First, the dash on the left side of the screen is not present in the default view in GNOME. The dash is available in the Activities view (you can move the cursor to the upper-left of the

The Fedora 25 desktop running GNOME's Software and Nautilus applications
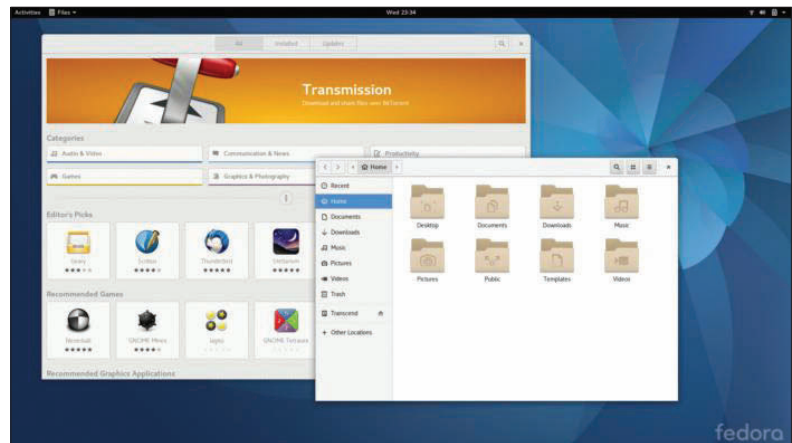
screen or tap the Super/Windows key to open it). With the Activities view open, you can see open windows, launch apps from the quick-launch bar, or start typing the name of an application, file, or web search.
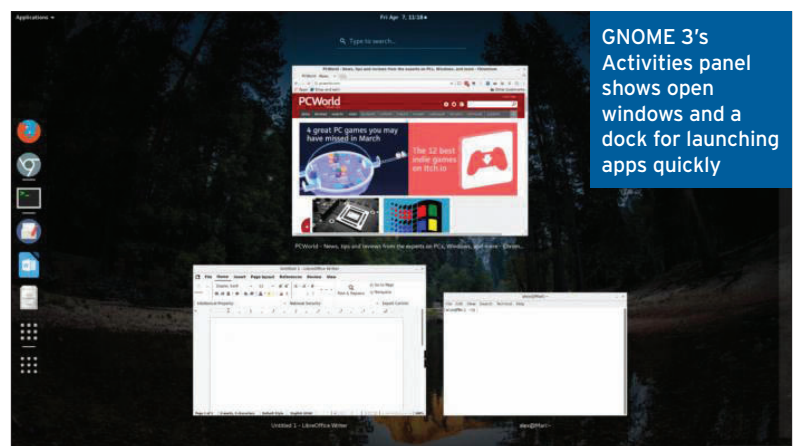
If you're used to searching for apps and files in Unity, the process is similar in GNOME. That means that even though it might take a little time to get used to, the learning curve won't be as steep as you think.

Conclusion

With the death of Unity, Ubuntu is rejoining the pack when it comes to desktop environments. If you've never used Ubuntu without Unity, this will feel like a big change. But for those who have used the operating system since before Unity was a glimmer in Canonical's eye, the move may feel more like Ubuntu is returning to its roots. ⊠

GNOME 3's universal search helps you find apps, files, and contacts

GNOME 3's Activities panel shows open windows and a dock for launching apps quickly

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